Engineering News-Record

Devoted to Civil Engineering and Contracting

McGraw-Hill Company, Inc.

December 17, 1925

Large Channel Dredging Project at Portland, Oregon — Highway Progress in the South Atlantic and Gulf States: Alabama — Let the Contractor Develop "Consumer Appeal" — Building a 29-foot Concrete Arch Sewer at Richmond, Virginia — Sixth Article on Soil Mechanics: Elastic Behavior of Sand and Clay

River Dredging and Low Land Reclamation, Willamette River, Portland, Ore.

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Editor

Volume 95 NEW YORK, DECEMBER 17, 1925 Number 25

The President's Messages

PRESIDENT COOLIDGE'S opening and budget messages to Congress last week followed expected lines of conservatism with hopefulness for steady if slow progress along the lines he projected two years ago and has held to since with dogged New England persistence. His note of warning that expense cutting must be expected to come to an end soon was sound and timely, since obviously much of the reduction that has taken place has been incident to the substitution of a peace-time for a war and post-war period. The protest against putting debt redemption on a 62-year basis, as has been advocated in some quarters, was one of the soundest utterances that could be made. What burdens of war or peace the nation may be carrying a half century hence is altogether too uncertain to warrant leaving our world-war obligations until that time, even if some of our creditor nations will, through dire necessity, just be concluding some of theirs at that time.

Three-Day Eye-Openers

MUNICIPAL administration in all its far-reaching complexities can hardly be taught in such three-day schools for city officials as met for the fourth time at Lawrence, Kan., Dec. 15-17, under the auspices of the University of Kansas. No one expects that much, especially of a miscellaneous assembly of mayors, city managers, commissioners, councilmen, city clerks, health officers, engineers, superintendents, operators and others interested in problems having to do with such municipal utilities as water-works, water purification, sewers, sewage disposal, etc. The statement of subjects for consideration, combined with the information that the instruction is to be given by the School of Engineering in co-operation with the State Board of Health makes the outcome more promising. The inclusion of mayors, councilmen and others with the men in technical charge of operation is commendable, as promising broader outlook over and a keener insight into the many problems with which they are confronted. Three days' attentive presence at such a school should be an eye-opener for the general official and the operating men as well, and with intensive courses for the latter it may really give them some grasp of technical administrative detail.

Township Road Improvement

INSTRUCTION of township highway officials in good practice in road improvement is a duty which has been inadequately performed by state highway departments. A few states have taken up the task and have reached a position now where they are exerting considerable influence toward the better handling of township road work but in general highway departments have assumed that direction of any sort not specifically requested was apart from their jurisdiction. Indeed they have much to excuse this attitude. The laws under which state highway departments operate generally do not contemplate, and much less do they provide, that the state road body shall have any part in administering local highways. There is, too, very general exhibition by small communities of extreme intolerance of state assumption of any rights in their local road affairs. To thrust themselves into the township road situation under these conditions has been a hazard which most state highway departments have been slow to venture. Generally they have found all the risks that they cared to undertake in keeping the public satisfied with their management of the tasks with which they are specifically charged. The duty of helping the township road to a higher place in highway management has, however, been generally recognized by state road officials. In the proceedings two weeks ago of the meeting of the Highway Research Board casual mention of the problem brought out a flash of discussion which showed the very active concern of many highway engineers in its solution. Indeed there is apparent on the slightest thought an opportunity for very practical service by state road departments in educating township officials to higher standards in road building and upkeep.

In Fairness to the Court

THREE weeks ago, in our issue of Nov. 26, we commented on the deterioration of duralumin in relation to the wreck of the dirigible airship "Shenandoah." We described the nature of the corrosion which was attacking the material of the airship frame, and charged that the court had not brought out the facts concerning this deterioration, and that the valuable information was withheld from public knowledge and was buried. This latter statement, based on incomplete information, was in error. The court did inquire quite extensively into the deterioration phenomena. Extracts from the testimony printed in this issue (p. 1000) bring out the essential facts: the occurrence of intercrystalline corrosion, the accompanying loss of ductility, and —indirectly—the fact that this deterioration was known since last spring. The court also inquired, it is shown, into the question of whether and how the corrosion can be prevented, the reply indicating that we are still largely at sea on this point. Our statement of the main facts of the deterioration is confirmed by the testimony and the conclusions we drew are as appropriate today as at the time they were written. But the charge that the court did not inquire into the decay of the metal and limited its inquiry to obtaining an opinion that the ship's strength was unimpaired is manifestly wrong and unfair. In due fairness to the court it should be noted that the testimony and cross-questioning give evidence of a conscientious desire to place the full facts of the deterioration on the court record.

Governor Pinchot's Call

SELDOM does a governor in calling an extra session of a legislature include in his summons so many engineering problems as were contained in last Sunday's announcement by Gifford Pinchot of Pennsylvania. Of the eight subjects to be considered four relate to engineering or closely allied matters: (1) Regulation of anthracite coal production—just now, non-production; (2) adjustment of the Pennsylvania-New Jersey differences over making the Philadelphia-Camden bridge over the Delaware a toll bridge, as was the understanding of the people of New Jersey when they voted bonds for its construction, or a free bridge as Pennsylvania subsequently demanded; (3) legislation for carrying out Governor Pinchot's giant power plans; (4) approval of the Delaware River Tri-State compact with New York and New Jersey for the control of water-supply and water-power development. Our present purpose is not so much to discuss the merits or demerits of Governor Pinchot's projects as to call attention to the prominence of engineering and allied topics in this announcement, a feature becoming more marked year by year in state and federal legislative programs and acts.

City Population Disappointments

RUMORS that the population of New York City, as determined by the state census of 1925, will be reported as 5,900,000 have aroused the sort of talk common in a city when a new census gives figures of growth that are disappointingly low. Since the average yearly population increment was considerably less for 1910-20 than for 1900-10, it is not surprising that there should be a further decline in the half decade between the 1920 federal and the 1925 state census, although it might be argued that the 1910-20 rate decline was abnormal and that by now there should be recovery from it. Details may be gone into better when the 1925 figures are officially announced. Meanwhile we suggest that it is a pity to begin this early to talk about discontinuing the state census entirely. Rather, if unjustifiable error or intentional omission for partisan reasons related to reapportionment of representation in the legislature can be proved, let the effort be to guard against them in future. The ten-year interval between federal censuses is altogether too long, at least so far as the main intent of a census is or should be—to determine population.

More on the Metropolitan Water Report

SO MANY interesting points were suggested by the report on an additional water supply for the Boston Metropolitan Water District and the City of Worcester, abstracted and commented on in our issue of Dec. 10, that two were passed over with less editorial attention than they deserved. One centers in the recommendation to utilize nearby sources of supply instead of going far afield, associated with which is the unusual feature of geographical or district representation on the investigating commission; the other is the commission's proposal for a strong reinforcement to what might be termed the main branches of the delivery system to the several communities served, and particularly a deep pressure tunnel from the end of the existing Boston aqueduct to the heart of the metropolitan district.

As many of our readers will remember, and as was brought out in the abstract of the present report in our issue of Dec. 10, p. 944, the so-called Joint Board of 1922 recommended going to the Ware and Swift rivers, the western drainage area of which extends well towards the Connecticut River. What seemed to many at the time like a master stroke in disarming the opposition of local manufacturers and others in these drainage areas was the proposal of the Joint Board to take flood flows only, but this did not prevent determined opposition to having the metropolitan district go so far west for water. This opposition, combined with a minority report contending that nothing be done in the way of construction projects on the Ware and Swift rivers for the present, and concern for the interest of the city of Worcester, led the legislature of 1924 to stipulate that only one of the members of the investigating commission of three should be a citizen of the metropolitan district and the others from the outlying territory.

The requirement that one of the three members of the investigating committee must be a resident of the part of the state from which it had been proposed to take water is unique in connection with investigations of this kind, but it should be noted that the Massachusetts metropolitan water district is a state project to an extent not matched elsewhere on joint water projects, since the state finances and constructs the water supply system. Notwithstanding the remarks on compromise that have been made, we do not intend to imply that the findings and recommendations of the commission are not based on sound engineering. At the most, they give recognition to that school of water supply engineering that is inclined to favor taking a relatively nearby source even though more polluted than a relatively distant source and depending upon filtration for safety. The recommendations in favor of the nearby source also give weight to another line of consideration common among engineers, which is the curtailment, where possible, of immense capital outlay at the start for works, considerable portions of which cannot be utilized because the water will not be needed for years to come.

It may be said further of the decision in favor of the nearby sources for the Boston section that the opposition to going scores or a hundred or more miles distant for water for a large city or metropolitan district seems to strengthen as the years have gone by and with it the distances and the water collecting areas have both increased. There is in some cases more logic to the opposition now than in the days before water purification was firmly established, for although the need for pure water is far more evident now than formerly, that very fact lessens the argument for the distant source whenever it is apparent that despite remoteness the water will have to be purified, soon, if not immediately.

As to better main distributories for sectional or district delivery of water, that is becoming increasingly important as land areas and volumes of water supplied increase. The multiple conduits side by side in the old Croton supplies for New York City gave way in the Catskill system to a deep pressure tunnel with uptake shaft en route connecting with the distribution network and with radiating pipe lines from the lower end of the pressure tunnel. This general plan was recommended in the latest reports on additional water supply for Philadelphia and Kansas City and now comes to the front in the Boston metropolitan report. Doubtless it will appear frequently in the future.

A Discouraging Showing

AT WILLISTON, North Dakota, the physical plant of the pumping irrigation project constructed by the government has been sold to a private concern because the project was an agricultural failure. The sale of another federal irrigation project in the semi-arid region is under discussion. Wherever a crop can be grown in occasional years, irrigation development is hazardous; the farmers are tempted to depend upon uncertain rainfall rather than go to the trouble and expense of irrigating. Largely for this reason the Garden City project, in Kansas, had to be abandoned a number of years ago. But in the drier country farther west, where farming without irrigation is quite impossible, it would seem that a well-planned irrigation enterprise could not fail to succeed.

On this point, however, surprising figures are presented in the annual report of the Commissioner of Reclamation, just made public. They make a thoroughly discouraging showing for federal reclamation—so discouraging a showing as to raise fundamental questions concerning the practicability of federal operation of irrigation works. There is strong presumption that the whole system under which the government has been carrying out these undertakings is wrong.

In five years the projects have piled up unpaid debts to the government totaling $8,500,000. Almost half of this amount is due for mere running expenses, which ought to be paid as promptly as taxes. For the last fiscal year alone more than half of the $6,000,000 due for running expenses and first-cost installment remained unpaid, while some five millions was still owing from the preceding four years.

It might be thought that agricultural conditions were unfavorable. The facts do not support this view. There were some crop shortages and other farmers' worries, but the projects which paid the smallest proportion are not the ones on which bad agricultural conditions existed. In short, the plea of unprofitable farming which the project politicians have urged as excuse for half a dozen years past is threadbare and must be discarded. The showing of the past two years, with good crops and prices, point to other factors as responsible.

Some of the trouble arises from private debts. Local payments and the like have come to take precedence over water payments to the government, though in theory and law the latter have first claim to be paid. Moreover, a generally demoralized sense of financial responsibility has grown up. This is illustrated by an incident told of in the Commissioner's report:

> On one project the water users' organization, in an appeal for blanket deferment, said: "Not one irrigator on this project can pay anything." This request was denied, but water users were told that individual applications showing the reasons for non-payment would be carefully considered. Thousands of dollars came at once into the reclamation treasury from those who could not make such a showing. . . . On another project owners of fine farms with the best crops in years refused to pay a cash installment of 15 per cent on *last year's* operating charges.

Strong effort was made by the reclamation officials to deal with this financial demoralization, and a few collection suits were started. Before the suits could go to trial, the money due was paid.

In the background of the situation is the fact that three times within the last four years Congress passed blanket laws permitting postponement of the payments due from the reclamation farmers. Last year's debt deferment law alone compelled the Reclamation Bureau to grant postponements totaling nearly $5,000,000. No business can run on such a basis. Something is wrong: either the extension of credit or the prior conditions that lead to this credit extension. Either cause would be sufficient to put a private business into receivership.

The facts as to production do not show that farming on the reclamation projects is an impossible or difficult enterprise. Figured on a cropped area of nearly 1¼ million acres, the average yield in 1924 was $55 per acre, and for 1925, with higher prices, the figure will be even better. It was brought out last week in hearings before the House appropriations committee of Congress that on a majority of the projects the ability of the settlers to meet payments is beyond question. Under a sound administrative system, in short, the projects would be sure to pay.

There is no good reason why a business should not be operated soundly merely because it uses public money and is administered by a government department. Dr. Mead in his direction of reclamation affairs during the last two years has striven hard to make the business sound, and he has succeeded to a remarkable degree; yet he now finds it necessary to report that on the whole the financial status of federal reclamation is bad, so far as repayments are concerned, and that a number of the projects are going down hill in morale! Even their reputation appears to be bad; 500,000 acres on the projects remain unfarmed, and settlers are slow to come.

These facts are most discouraging. They mean that the federal reclamation policy as administered by Congress and successive secretaries of the interior has been of questionable effect. The evil state of the majority of the projects is not redeemed by the prosperous upbuilding of a few. The projects are excellent engineering developments; they have been carefully and ably planned, the irrigation works have been built well and supply efficient and cheap irrigation to fertile land, well worth farming. Responsibility for the discouraging outcome must be sought in the general system and policy, not in the plan and construction.

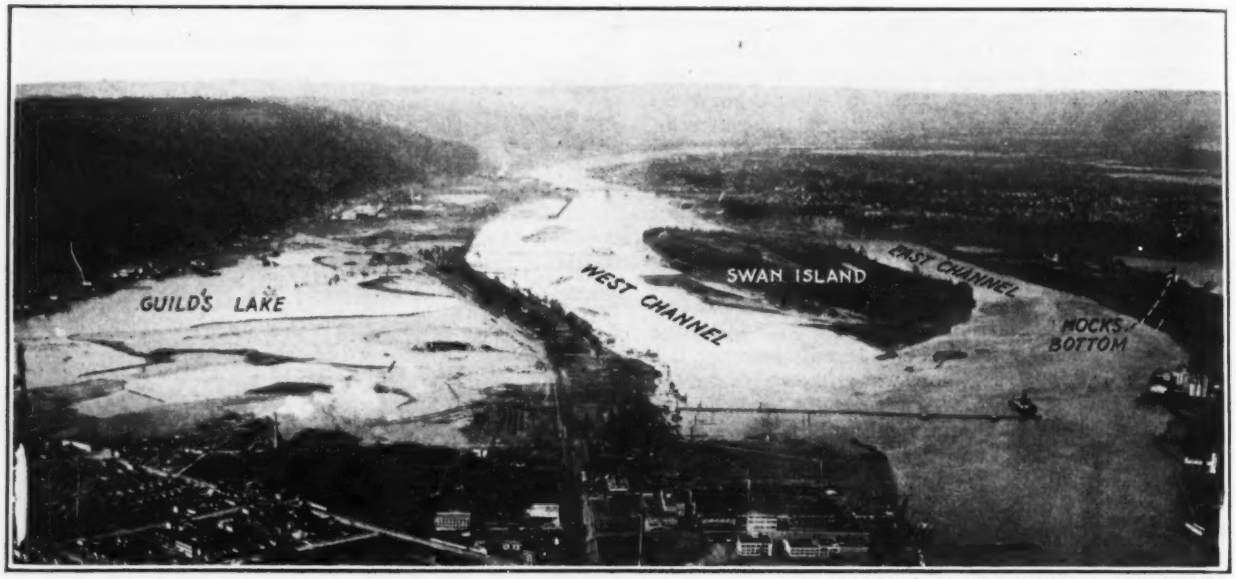
A clue to one part of the answer is found in Secretary Work's confession in his report recently submitted to Congress: "Two years are not enough to correct the errors of inexperience, lack of vision, or mistake in policy." This same truth has been discovered by previous secretaries of the interior, usually too late to remedy the demoralization they had brought about. Other elements of the explanation are supplied by the constant interference of Congress in the conduct of the reclamation business. In fact the whole history of reclamation is marked by a series of policy changes and other disruptive actions by successive secretaries of the interior, and by change after change in the laws governing the relations of the settler to the government: For nearly twenty years our greatest national development enterprise has been in politics, where local demand or protest has a louder voice than the general public interest.

Herein lies the essential disease of federal reclamation. And it is not likely that reclamation will be made sound until this political disease is cured. The remedy is in the hands of Congress: Let it bind itself to keep from meddling with the business by ever new legislation, and let it place upon the official in charge of administration direct responsibility for making reclamation pay.

Large Channel-Dredging Project at Portland, Ore.

Material Handled for 6c. per Cu.Yd. in 50,000,000 Cu.Yd. Job on Willamette River—Electric Pumping—Dredge Records Unusual—Reclaiming of Land for Waterfront—Work About One-Fifth Done

CHANNEL improvement in the 12-mile stretch of the Willamette River between the city of Portland, Ore., and the Columbia River, is in the hands of the Port of Portland—a commission whose function is to improve the river channel and the harbor facilities generally. In recent years with a channel 30 ft. deep for the entire 112 miles from Portland to the sea, the commission has given more of its attention to widening and deepening the harbor proper and those river channels close to Portland particularly where areas valuable as industrial sites could at the same time be filled in. The largest project now under way is the work being done at Swan Island, just below the city, where some 50,000,000 cu.yd. is being moved to make a new channel and incidentally is being used as a fill on 1,500 acres of flanking lowlands. About 10,000,000 cu.yd. have been moved to date and with a new dredge of very large size put in service last August it is expected that the work will be completed within the next four years. Material is being moved at remarkably low cost as set forth in the following.



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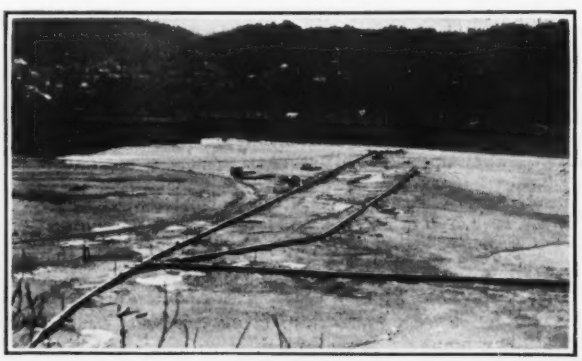
AIRPLANE VIEW OF SWAN ISLAND PROJECT

The basis of this work is the development of the west channel of the Willamette River abreast of Swan Island to a width of about 2,000 ft. and a depth of minus 35 ft. U. S. E. datum, the dredge material being deposited on some 900 acres of swamp and overflow lands in the Guild's Lake area adjoining the manufacturing and jobbing district of the city. Later the east channel is to be dredged to its full width of 700 ft. and along with it some 700 acres of swamp land on the east side of the river known as Mock's Bottom will be reclaimed for future industrial purposes.

On this job the commission is using four 30-in. hydraulic pipe-line dredges and two 1,600-hp. auxiliary or booster pumping units, the latter being required when very long discharge lines are necessary. These electric boosters are not self-powered, but secure current from shore by means of submerged cables. They are said to be the first dredge relay pumps of their size to be served by an 11,000-volt submerged cable, utilizing slip-ring contactors to permit constant moving of the plant without requiring shutdowns to make power-line connections. Their power consumption varies from 1½ to 3½ kw.-hr. per yard, depending on the kind of material boosted.

Two of the dredges are equipped with 1,500-hp. reciprocating engines connected to centrifugal pumps operating normally at 140 to 180 r.p.m. A third dredge, rated



SHORE END OF 30-IN. DREDGE LINE IN GUILD'S LAKE

A 32-ft. fill is being made in this area by material discharged only from the end of the pipe. Flow is confined to one branch line while extensions are made on others.

TYPES OF CUTTERS FOR DIFFERENT MATERIALS. AT LEFT, CUTTER CAKED WITH HARD CLAY
Those with open framing are used for clay. Where much trash and sticks are encountered the close-set knife type is used. When the cutter becomes caked with clay, the suction is blocked.

at 2,000 hp., is equipped with steam turbines, driving a pump of smaller diameter at 280 to 300 r.p.m. and able to deliver material through very long pipe lines without booster aid. This dredge, the "Tualatin," handles a high percentage of solids through a delivery line a mile long, unaided, while the slower speed low-powered units require boosters when the pipe line exceeds 3,000 ft. in length and the lift 30 ft.

The fourth dredge, the "Clackamas," which was put in service last August represents new departures in design. Its initial power is derived from four Diesel oil engines totaling 3,400 b.hp., direct-connected to electric generators which supply current for individual motor drive throughout the dredge including a 2,700-hp. adjustable speed motor, direct connected to the dredging pump.

In planning the new Swan Island channel an assessment district was formed and in general a 50-50 basis was worked out for apportioning costs, that is, the Port paid one-half of the cost of making the channel improvements while the owners of reclaimed lands paid the other half, the Port for the most part accepting waterfront lands in payment. This brings into commission ownership some three-quarters of a mile of frontage on the new channel on the west side of the river.

In analysis of costs made at a time when the total yardage moved had been 8,650,970, the actual dredging cost was found to be $0.063 per cu.yd., made up of the items of dredge operation, shore work, overhead and booster operation, as shown in the following table:

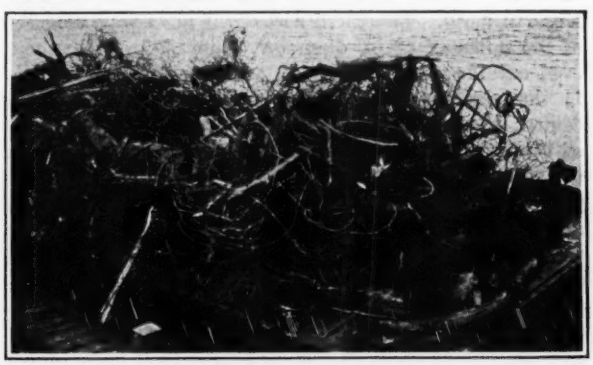
Item	Cost per Cubic Yard
Dredging only (including all dredge and pontoon pipe items)	$0.0417
Shore work, including handling pipe lines, shear boards, dredge discharge, etc.	0.0101
Miscellaneous costs, including bulkheads, pipe-line trestles, job overhead for insurance, etc.	0.0068
Booster operation	0.0044
Total	$0.0634

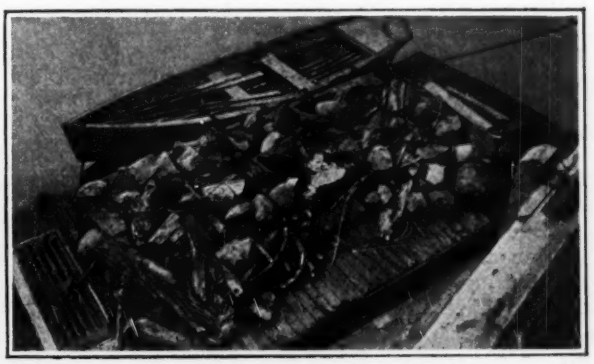
The boosters handled only about one-fourth of the total yardage and at a cost of $0.0171 per cu.yd. of material actually handled. However, considering the project as a whole the total booster cost was spread over the total yardage handled. In this work the average pipe length was 3,205 ft. and the maximum length 10,200 ft. The maximum yardage handled by one dredge in a 24-hr. day was 47,250, and the monthly maximum was 727,440 cu.yd. The lift against which most of this pumping has been done averages about 29 ft.

In general, the output of one of the three dredges used on this work varies from 2,000 to 50,000 cu.yd. per 24-hr. day, depending upon the material being moved. The operating cost of the dredges is a more or less fixed quantity, amounting to about $600 per day per dredge.

The cost of operating a 1,600-hp., 30-in. booster, exclusive of interest or depreciation charges, and with electric current at 0.6c. per kw.-hr., is as follows:

Item	Cost per 24 Hr.	Per Cent
Operating labor	$ 47.00	16
Maintenance	48.00	16
Power	112.00	39
Other supplies and expenses	16.00	6
Overhaul repairs (Reserve)	67.00	23
Total	$290.00	100
Cost per pumping hour	19.00	





TRASH REMOVED FROM PUMP RUNNER AFTER PASSING THROUGH CUTTER
Each bargeload represents an accumulation from a 24-hr. run. This indicates the importance of convenient access to the pump runners.

Almost all kinds of material have been handled, notably sand, clay, pea gravel, conglomerate of clay and gravel, hardpan and, most troublesome of all, material in which there is a large amount of trash, such as wire rope, small boulders, sticks and stumps.

It has been observed on this work that coarse sharp sand requires high pipe-line velocities to keep it from settling and on account of its sharpness is very destructive to the pipe necessitating high head pressure to overcome frictional resistance. Sand containing a small amount of clay makes ideal hydraulic dredging material, the clay acting as a lubricant.

In dredging clay the chief difficulty is usually with the cutter head. Clay is difficult to remove from its bed and supply through the pipe line in quantities sufficient to give efficient results. Sticky clay adheres

TYPICAL TRESTLE LINE DEPOSITING THROUGH TRAPS
By this method the dredge "Tualatin" has completed 150 lin.ft. of sand dike to a height of 32 ft. in one day. The fill takes a slope of 7 to 1 when placed in this way.

to the cutter blades and ultimately stops up the suction openings, necessitating shutting down the dredge and raising the ladder to clear the cutter. Once the clay passes the cutter and is surrounded by water it becomes "slick" and passes through the pipe with very little resistance, especially when in chunks. Clay of the kind easily disintegrated by water becomes a thin mud which requires a very large settling basin to prevent it from flowing off with the water and leaving practically nothing on the fill.

Gravel requires a much higher pipe-line velocity than any other material, as the heavy particles tend to settle rapidly and drag along the bottom, increasing resistance. The high velocity required and the difficulty of getting the gravel through the pump results in the delivery of only a small percentage of solids.

To meet the varying conditions of these different materials and to make effective delivery of a high percentage of solids requires cutters of different design which can be used at different speeds and with different powers. Hardpan requires slow speed and high power while fine sand or silt calls for high speed and rapid feed to the pump. Various types of cutters have been designed by the Port of Portland to meet different conditions. These cutters are about 5 ft. long and 6 ft. or more in diameter, and are all made with square hub sockets of uniform size so as to be interchangeable on the different dredges.

Where trash, such as logs, stumps, sawmill refuse, etc., is encountered, closed pipe cutters are preferable as the openings limit the size of objects that can get to the pump, thereby reducing the danger of clogging. Blades of the closed pipe are also stronger and better able to withstand the chopping action which takes place in handling such material. The cost of maintaining pump liners as well as the wear and tear on pipe line is greatly increased by sharp sand and gravel, while hardpan or other material that has to be cut from its original position runs up the maintenance and repair costs on ladder and cutter.

If the material samples, which are taken daily, give a true and reliable indication of the material encountered, then the cutter speed, pump pressure and other factors can be closely suited to the requirements and an accurate prediction can be made of the day's output. The material handled, however, is likely to suddenly and entirely change its character which necessitates both close observation and experience with the different materials to keep the dredges operating efficiently.

The dredge fleet is under the general direction of James H. Polhemus, general manager and chief engineer of the Port of Portland, to whom *Engineering News-Record* is indebted for material contained in the foregoing.

Cement-Mortar Lining Used for Metal Portions of Aberdeen Aqueduct

CEMENT mortar was used as a lining for 13.1 miles of 48- and 40-in. steel and 3 miles of 48-in. cast-iron pipe constituting the main pressure portions of the new aqueduct for the water supply of Aberdeen, Scotland, according to a paper by George Mitchell, city water engineer of Aberdeen, read before the Institution of Civil Engineers. For the cast-iron and some of the steel pipe the lining was 2 to 1 mix, 1 in. thick. The remaining steel pipe had a ¾-in. hand-placed lining.

The water supply of Aberdeen is treated by slow sand filtration before it passes through the aqueduct. The new aqueduct is part of extensive improvements designed to serve an estimated future population of 240,000 with 48 U. S. m.g.d. per capita. The present population is about 160,000.

Before the steel pipe is reached the water passes through a Venturi meter and 0.7 mile of horseshoe-shaped concrete conduit, 5½ x 3⅝ ft. in section. Next comes two miles of 48-in. pipe, made up into 20- and 25-ft. lengths from 7/16-in. mild steel plates, uncoated on delivery, but afterwards cleaned outside and painted with one coat of Bitumastic and one coat of Bitumastic enamel, applied hot. The next section—1.5 miles of 48-in. pipe made from 5/16-in. plates—was coated on the outside with Mexican asphalt and wrapped twice with Hessian cloth. The third section of steel pipe consists of 9.6 miles of 40-in. diameter, from 7/16-in. plates covered outside with Mexaphalte and Hessian cloth. This is the stretch of steel pipe with centrifugally-spun cement mortar lining. The mortar for about 6 miles of this stretch was mixed in a special machine, outside the pipe and for the remainder it was mixed inside the pipe while being spun. The final section of metal pipe, and the last part of the conduit under considerable pressure, was three miles of 48-in. cast-iron pipe. Finally, came 0.6 mile of 48-in. concrete pipe under a low head.

Circumferential joints for the first stretch of 48-in. steel pipe (and presumably for the second stretch) had sockets 4½ in. deep, "filled partly with hard calked cement mortar and partly with lead wool 1½-in. deep." The depth of lead in the joints of the 40-in. steel pipe was 2½ in. For the cast-iron pipe, "lead wire 2½ in. deep was used for jointing, the sockets being 3½ in. deep."

Let the Contractor Develop "Consumer Appeal"

One Way Suggested Whereby the Business of Constructing May Be Bettered and Stabilized

In "Engineering News-Record," Sept. 17, 1925, p. 456, W. J. Barney, a New York contractor, stated some of the difficulties of present-day contracting under the title, "What Is the Matter With Contracting?" The following article presents one answer formulated by the Morton C. Tuttle Co., engineer-contractor, Boston, Mass. The article is the joint product of the staff of that company and is not, therefore, assigned to any one man as author. It will be read as an excellent presentation of the arguments in favor of the large contracting organization which is at the same time an engineering organization, capable of, and frequently performing, both the engineering and contracting functions in any one job.—EDITOR.

FROM the vantage point of long experience and observation, Mr. Barney calls attention to the disorganization which exists in the contracting business as a whole, and the consequent failure of that business to show average net profits commensurate either with the capital expenditures involved or with the profits which, statistics show, are derived from manufacturing enterprise in general.

The Contractor's Troubles Summarized—Mr. Barney attributed this unsatisfactory situation to two main causal circumstances.

There is, first, the large proportion of contractors who, without knowing the processes of scientific estimating, enter competitions for construction contracts with bids whose low figures are due to miscalculation as to quantities called for, as to normal unit costs to be expected under the given conditions, or as to probable fluctuations in the labor and materials markets during the life of the contract. Second, Mr. Barney found architects and engineers all too ready to justify the fee which an owner pays for their services by "shopping a job" until they have found some misguided contractor who will quote an absurdly low figure for it. This accomplished, Mr. Barney found it common practice for architects to use the low offer as a club for hammering down the proposal of a responsible bidder. If such dubious measures fail, it is, he stated, not uncommon to award a contract to the low bidder in full knowledge that delay, scamped quality, financial loss, and general dissatisfaction are more than liable to result.

As a means of improving matters Mr. Barney suggested a closer association of contractors to the end of establishing methods of specification that shall be uniformly clear, methods of estimating that shall be uniformly correct, and methods of approach to the whole process of competition that shall be uniformly fair, just, and above board.

Contracting a Branch of Manufacturing—Most of us will agree, without much demur, that Mr. Barney has described an existing situation with accuracy and fair-mindedness. It may, however, be questioned whether he is fully justified in making comparison between a single line of business so essentially competitive as that of contracting and the whole field of manufacturing, with its innumerable subdivisions—some of them high profit specialty enterprises, some producers of widely used products whose price is protected by government patents. As a matter of fact, we, on our part, have frequently pointed out—and still believe—that contracting is, in itself, a branch of manufacturing, to whose controlling principles it is, in turn, subject.

If we examine the whole case from this standpoint, we shall find that other lines of manufacture besides building are highly competitive, and that they are as vulnerable, as building, to the price cutting of ignorance, incompetence and sharp practice. For some years producers of various lines of cotton goods, of shoes, of clothing, and of what not else have found their paths of upward progress seriously obstructed by the debris from over-venturesome competitors, who, having lost their foothold, proceed to tear the landscape to pieces in frantic efforts to catch at any rootlet of hope that may serve to halt their descent toward bankruptcy.

Association No Real Remedy—When it comes to the consideration of remedies, it may, we believe, be doubted if any class of manufacturers has ever found that closer association has afforded adequate protection against irresponsible competition. The right to commit financial suicide—to the detriment of everybody except the individual who may consider himself enriched by retrieving a derby hat and a frayed coat from beside the river's brim—is one of the rights most carefully protected in this country of ours. It is known as the right of unrestricted competition; and, while it produces a painfully high mortality rate, those who interfere with its functioning are viewed with suspicion by the all-seeing eye of an omnisciently paternal government.

Associations, no doubt, possess their manifest benefits, but they can no more eliminate the costly competition of jitney incompetence than a safety first campaign can prevent jay walking on railroad tracks. The condition which Mr. Barney described may be an intolerable one, but the only way of escape from it which is open to legitimate contractors is probably the same that has been traversed by successful manufacturers of a great diversity of products for personal and domestic use, namely, that of direct appeal to the ultimate purchasers of their goods.

The Consumer Appeal Justified—The fact of the matter seems to be that the average agent, by whatever title the nature of his employment leads him to be known, may not be relied upon to view his function as essentially other than that of securing a favorable price in behalf of his principal, without very much regard for the quality which that price implies.

Between the American public and the industrial manufacturer the retail storekeeper stands as agent. How many of his tribe are ready, of their own volition, to accept any motto other than that of, "we will not be undersold"? The one chief influence, indeed, which prevents the average retailer from driving the hardest possible bargain with the producer, as an alternative to purchasing in the bankrupt market, is nation-wide consumer-advertising on the part of that producer. By means of such advertising, and by such means only, the public has been taught to pay a fair standard price for a standard article, on the assurance that back of each purchase lies known quality safeguarded by reputation.

But education of the consumer by the manufacturer has not eliminated irresponsible competition. It has merely accomplished the assurance of a reasonable profit to those concerns which are able to convince the public of the superior value of their name and trademark. Incidentally it has, perhaps, relegated the ubiquitous bankrupt to the bargain basement.

Where are the snows of yester year? queries the poet. Where are the contractors of fifteen years ago? asks Mr. Barney. Insofar as we may judge, most of them have followed season's snows. The exceptions, in the main, have been among those who have emulated the surviving manufacturers in *convincing the ultimate consumer, namely, the building owner, that there is such a thing as superior service in contracting and that it is worth the modest fee which it demands.*

The Frailty of Architects—And the owner may be convinced; whereas his agent—the architect or the engineer—may not. It would, in fact, seem to many architects a dangerous admission of weakness were they to confess that they can *not* write specifications impossible of evasion or misinterpretation, and that they can *not* supply a supervision that shall insure the perfectly workmanlike fulfillment of every letter of the contract from the first dotted *i* to the last crossed *t*. They know in their hearts that they are thus incapable. They realize, well enough, that it is no more possible to specify and supervise a second or third rate contractor, with his random crew of mercenaries, into producing first-class construction than it is to write specifications for a portrait and then hope to direct some anonymous dauber into the painting of a masterpiece.

But to admit one's incapacities is to be shorn of some part, at least, of power; and human beings are loath to submit to such humiliation. Architects and engineers have so long viewed themselves as final arbiters in matters of construction that to have a contractor pass them by and make his appeal for consideration direct to the owner is certain to wound their sensibilities and give rise to accusations of unethical conduct. This is unfortunate; but the contractor who is responsible for so much distress may comfort himself with the assurance that, in addressing himself directly to the ultimate consumer, he is but following the course which the timidity, short sightedness, or greed of middlemen has made necessary to most other manufacturers.

Vision to See the Writing on the Wall—To push the analogy between contracting and other competitive lines of manufacture a step further, it may be pointed out that the highest grade of retail middlemen have, long since, come to recognize that this "consumer appeal" is of value to themselves as well as to the manufacturer; for it enables them to standardize and stabilize their stocks of merchandise and to justify their sales policies by the universally known merit of their wares.

By the same sign, many of the larger and more influential firms of architects and engineers have reached the conclusion that not only the welfare of their clients, but their own reputation for workmanlike service and ethical soundness is better safeguarded when they deal with a contractor of recognized standing than when they go slumming for bids. Such firms now make it a cardinal rule of their practice to assist their clients in the selection of contractors noted for their reliability rather than for their cheapness. It is, in fact, no longer uncommon to find architect and builder working together, almost from the outset of plan development, in order that, at each point of procedure, the builder's practical knowledge of structural economy may check with the architect's conception of adequate design.

A Distribution of Responsibility—Such a relationship, however, between designer and contractor constitutes too close an approximation of the millenial ideal ever to be of universal occurrence. It implies large and generous vision on the part of the architect or engineer, and the possession of similar qualities, plus a highly competent and well-trained permanent organization, on the part of the contractor. In such case the burden of responsibility placed upon the contractor is fully as great as that which rests upon the architect. To carry it the contractor must have developed cost keeping to the highest possible degree of scientific accuracy, and must have devised ingenious indices for making the indispensable records of many past years and diverse situations applicable to new problems.

True Quality Everywhere Scarce—The contracting firms which are equipped with any such arsenal of statistics as that suggested, and with the personnel competent to interpret them are, as Mr. Barney points out, perhaps even scarcer than architects of large and generous vision. And they will remain scarce so long as high competency in any field of individual or corporate endeavor continues to be a rarity.

These strictly high-grade contractors are, however, in no great danger of elimination through competition with irresponsibles, provided they so manage their affairs that they need not be stampeded into a war of price paring; and provided, further, that they give evidence of all-round vitality both by doing the best of good work and by making their qualifications known where such knowledge will prove beneficial. The latter implies, of course, the maintenance of a selling force, and the development of sales methods calculated to reach through the multitude of restrictions and inhibitions wherewith the consumer is hedged about, and not only to convince him, but to quicken him to action. How this is to be accomplished, however, is apart from the concern of the present notes.

Rendering Service at Right Recompense—The percentage of mortality in the contracting business is high and the average percentage of profit is low, primarily because anybody who owns a pick and shovel can become a contractor. It used to be comparatively easy to build success upon the foundation of such a humble equipment. Today it is not easy; it is virtually impossible; but the fact is yet to be learned by the majority.

Those contractors who have had both the vision and the liberality to build up an impregnable organization nucleus, and to maintain it in good times and in bad, who have established high standards of service and have backed them with a vigorous and unvacillating sales policy have survived, and have enjoyed, as well, a reasonable measure of prosperity. Proceeding exclusively on the basis of a fair return for services rendered, they have foregone the spectacular gains which accrue from success in speculative enterprise. But, in so doing, they have avoided the pitfalls which yawn all too abundantly for those who indulge in speculative competition for construction contracts.

Principles of Soil Mechanics: VI—Elastic Behavior of Sand and Clay

Testing Sand for Compressibility and Elasticity—Expansion and Resaturation—The Ideal Sand Cube and the Effect of Lateral Expansion—Comparison with Solids

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IN STUDYING the difference in compressibility of sand and clay, which constitutes the last item of the observed characteristics as listed in the preceding article (*Engineering News-Record*, Dec. 3, 1925, p. 912), the elastic properties of sand were investigated. For this purpose a method was used similar to that previously applied to tests of the elastic properties of clay. The sand was poured into a steel ring resting on top of a polished cast-iron slab, and either left as deposited or compacted by hammering the outside of the ring. The surface was leveled with the ring, covered with a circular cast-iron plate, and loaded either by the lever of a home-made loading device (low-pressure tests) or by the piston of a screw testing machine (medium- and high-pressure tests). The diameter of the ring used for the medium- and high-pressure tests was 15 cm. and its height 4 cm. Compressions were measured by micrometer with the help of the interference contact indicator. Tests on dry sand and on sand completely immersed in water showed no difference.

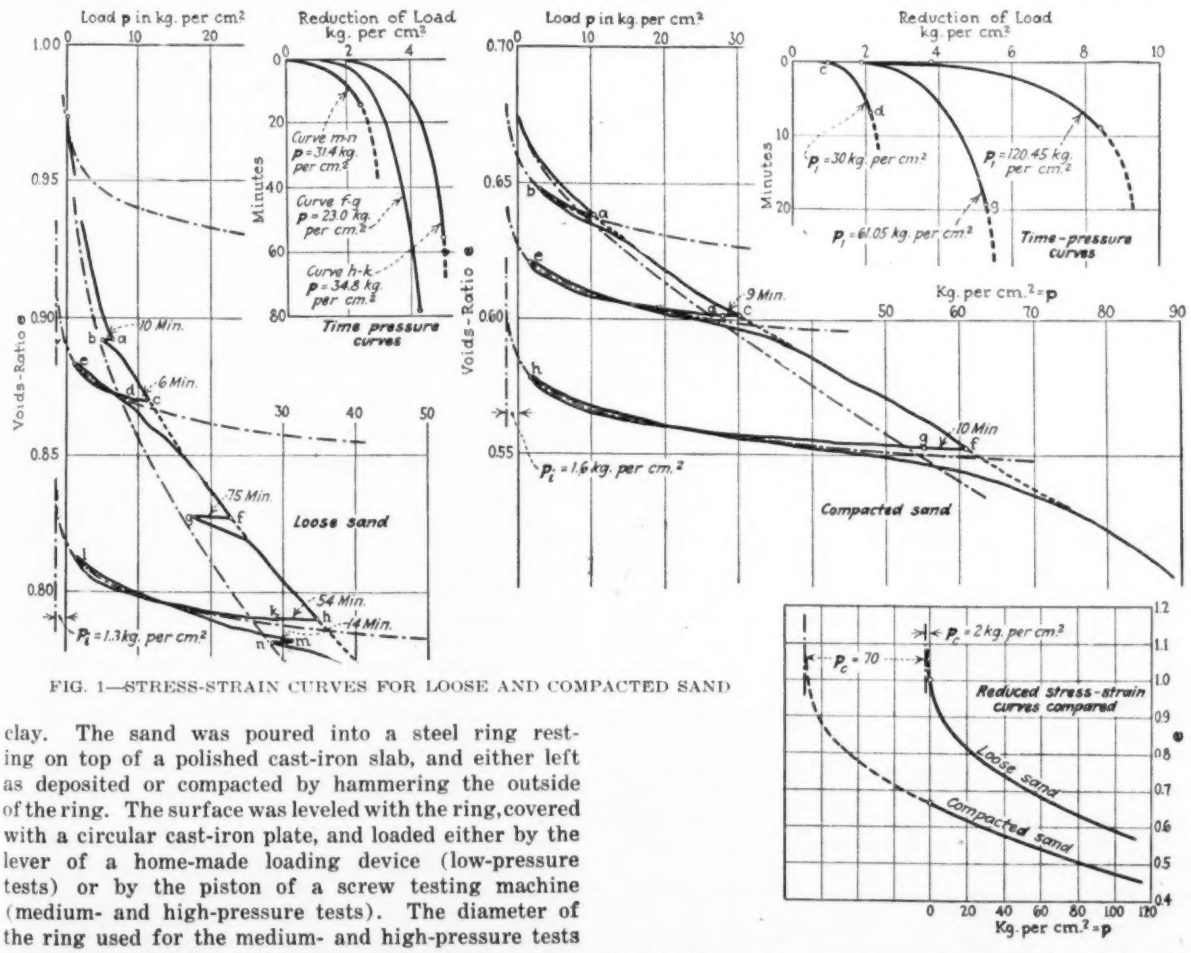


FIG. 1—STRESS-STRAIN CURVES FOR LOOSE AND COMPACTED SAND

Fig. 1 gives in separate diagrams the results of tests on loose and thoroughly compacted sand. In both cases the sand was a pure quartz sand produced by crushing white quartz pebbles, the product being sifted and washed; the grain diameter was 0.25 to 1.00 mm.

In the test on loose sand the initial volume of voids was 49.75 per cent (void-ratio 0.99). By means of a screw testing machine, pressure was increased at the rate of about 1 kg./cm². per minute to about 7 kg./cm². Then the machine was stopped for 10 min. (horizontal line *ab*) during which time the pressure exerted by the sand against the stationary piston decreased to about 5.5 kg./cm². Thereafter the machine was again started (curve *bc*), the load increasing to about 12 kg./cm². Again the machine was stopped, for 6 min. (*cd*), and then the load was released down to about 1.5 kg./cm². and reapplied (*ef*), forming a complete hysteresis loop and continuing the original stress-strain curve. A second load cycle was tried at higher load (loop *klm*).

The time-pressure diagrams (at right and above in Fig. 1) show the pressure-decrease while the machine was stopped. These curves are very similar to the time-pressure curves for clay cubes, and in fact they have the same simple differential equation. The gradual decrease of the pressure is due to a gradually proceed-

ing mutual compensation of unbalanced frictional resistances which at first take up part of the load.

If, instead of keeping the compression constant, we keep the load constant, the compression increases at decreasing rate, and the relation between time and compression is in every respect similar to the relation between time and compression for clay cubes under constant load.

Expansion of Sand—In the test on compacted sand, Fig. 1, the initial volume of voids was 40.2 per cent (void-ratio 0.673). The stress-strain curve is less steep than that for loose sand, while the hysteresis loops of both diagrams are almost identical. The close relationship between these diagrams and the corresponding diagrams for clay is obvious. In both, the loading cycles form curved hysteresis loops. In the sand diagrams, Fig. 1, the recurrent branches of these loops are expansion lines, but they correspond in every respect to the resaturation lines of the clay diagrams, and like the latter they are logarithmic lines, $e = A \log (p + p_i) + C$, where p is the external load (kg./cm.²), p_i is an initial constant having the dimensions of a pressure, A is the *expansion coefficient* of the sand, and C is a constant depending on the initial density of the sand. The expansion coefficient of sand corresponds to the resaturation coefficient of clay.

The expansion coefficient is almost independent of the density of structure of the sand. It was found to be equal to 1/100 for sand with very smooth grains and 1/176 for a sand with very rough grains. A very fat clay showed a resaturation coefficient of 1/22.3, a leaner clay 1/52.7, and a sandy mud 1/73. Thus sand is far less elastic than clay. The more sand a clayey soil contains the nearer its resaturation coefficient approaches the expansion coefficient of clean sand.

On the other hand the "initial pressure" p_i depends not only on the original density of the sand but also on the pressure at which expansion begins. This effect is due in part to the sand grains wedging together, in part to breaking of grains by the pressure, which in turn affects the structure. As illustrating the latter action it may be mentioned that a sand which initially was clean and dust-free was found, after its surface had been loaded to 50 kg./cm.², to contain 4.6 per cent of dust particles. The average value of p_i for sand (1.5 kg./cm.² for medium to high pressures) is very large, compared to the value for clay (approximately 0.002 kg./cm.²).

The effect of the unbalanced internal stresses on the stress-strain curve depends on the rate of loading. Under indefinitely slow application of load we would obtain the *reduced* stress-strain curve, shown by a dash line. How this line depends on the original density of the sand is represented by the third diagram in Fig. 1.

Fig. 2 shows typical stress-strain diagrams for a fat clay, a loose sand and a dense sand. The figure shows plainly that the difference between the elastic properties represented by the three curves is one of degree only. This difference, item (6) of the differences listed in the preceding article, Dec. 3, is a self-evident consequence of the fact that clay particles are scale-like. Sand can be compared to a pile of broken stone, while clay resembles a mass of flakes of paper. The higher the sand content of a clay, the less compressible and the less elastic it is.

Poisson's ratio for clay was computed from the lateral pressure in a loaded layer whose lateral expansion

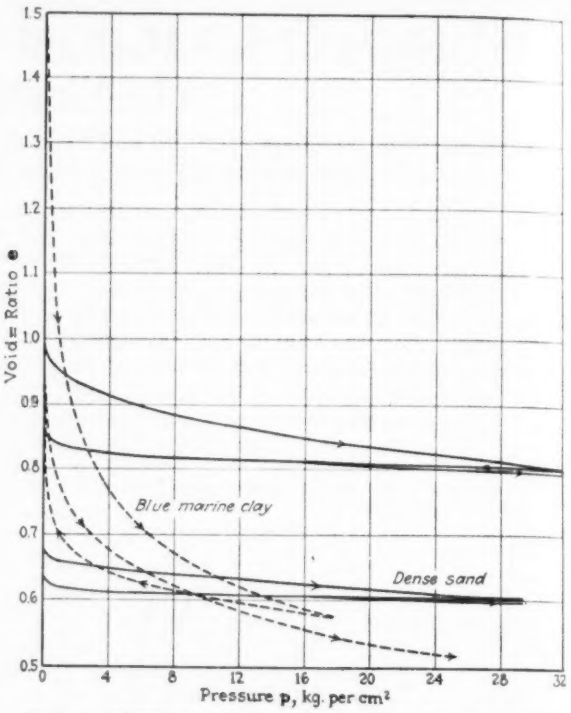


FIG. 2—PRESSURE-VOID (STRESS-STRAIN) CURVES FOR CLAY AND SAND

was prevented by a rigid enclosing ring. In a similar way Poisson's ratio for sand was determined. It has the value of 5.0 (as compared with 11 for Cooper sandstone, 5.1 for Troy granite, and 4.5 for Tuckahoe marble). Thus, while Poisson's ratio for clay is approximately identical with that of metals, its value for sand corresponds to the average Poisson's ratio for crystalline rocks.

Modulus of Elasticity of Sands—Clay is capable of being tested in the form of an unconfined cube. The particles of such a cube, before loading, are subject to no force except capillary pressure, acting like a hydrostatic pressure. Suppose the clay particles are replaced by sand particles without changing the intensity of the internal pressure; it is readily inferred that, as sand and clay have quite similar stress-strain diagrams for compression when confined laterally, the stress-strain curve of the sand cube would be of the same type as that of a clay cube, which in turn was found to resemble closely the stress-strain diagrams for a concrete cube.

Of course it is not possible to test sand cubes directly. On account of the large voids of sand the capillary pressure is very small, too small to hold the particles together. But on the other hand each cube-shaped element of the backfilling of a retaining wall is comparable to our ideal sand cube; capillary pressure is replaced by the confining pressure of the surrounding material. When the retaining wall is forced horizontally against the backfilling, a cubical element of the backfilling is subjected to forces quite like those acting on a compressed clay cube. Hence the stress-strain diagram ought to be of similar form. Experiment fully confirms this.

When a retaining wall yields under the pressure of the backfilling, any cubical element of the backfilling undergoes horizontal elongation. This corresponds pre-

cisely to the strain effect of a pull exerted on the ends of a clay prism. In such a clay prism the principal stresses at right angles to the pull are constant and equal to the capillary pressure, while the principal stress acting in the direction of the pull is a variable compressive stress, equal to the difference between the capillary pressure and the pull. This residual stress must obviously be a compression, not a tension, because the pull cannot possibly exceed the intensity of the capillary pressure. But this residual compressive stress decreases as the elongation of the prism increases. In the same way, the lateral earth pressure exerted by a cohesionless mass of sand against a yielding retaining wall must evidently decrease as the yield of the wall increases.

A confirmatory experiment is represented in Fig. 3. Two rigid vessels *A* and *B*, of similar form, are filled with sand as shown. Close to the side of each vessel and just above midheight there is within the sand a horizontal steel tape set on edge, between two sheets of smooth paper. In vessel *A* the tape is pressed against the wall by what I have called the *earth pressure at rest* of the sand, since near the tape the sand undergoes no lateral expansion after its deposition. In vessel *B*, on the other hand, the upper half of the sand body rests on the surface of the compressible lower half of the sand body, and this lower half compresses during the filling process, each layer moving downward and (because of the splay of the sides of the vessel) expanding laterally as it moves down. According to the theory above suggested this expansion ought to decrease the lateral pressure of the sand. Individual measurements of the force required to pull the tape are plotted in the figure separately for vessels *A* and *B*; in each case the lower group of points refers to the unloaded sand, while the upper set was obtained when a weight of 25 kg. rested on the sand surface. The figure shows that the lateral earth pressure was 43 per cent smaller in vessel *B* than in vessel *A*—obviously due to the lateral expansion of the sand.

A different effect resulted when the sand was subjected to a violent disturbance. The bottom of vessel *B* was placed on removable supports and, after a first series of pulling tests was made, this bottom was lowered suddenly a distance of 2 mm. Immediately thereafter the lateral pressure was somewhat smaller than before, but in time it increased, went beyond its original value, and after 24 hr. became as great as the lateral pressure in vessel *A*. The increase of the pressure was obviously due to the gradual mutual compensation of internal frictional resistances similar to those which cause the pressure in a clay cube or a layer of sand to increase when its loading is decreased and the height of the cube or layer is then held constant.

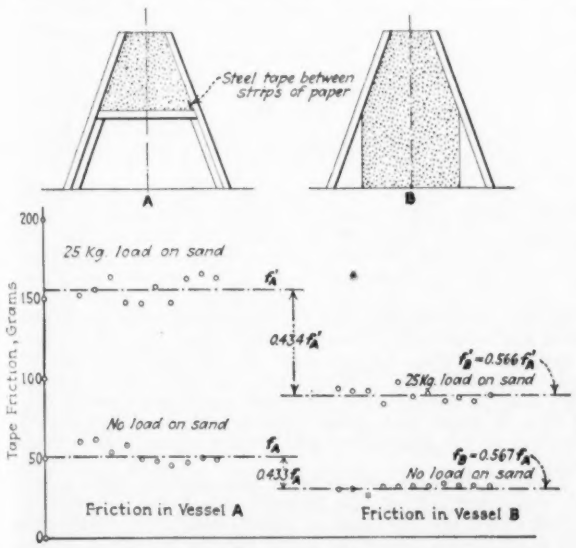


FIG. 3—LATERAL PRESSURE OF SAND
(Influence of yield and settlement).

Further evidence for the pressure-relieving effect of lateral expansion of a mass of cohesionless sand has been furnished by various earth-pressure tests of G. H. Darwin, A. D. Donath, and the author.

Some interesting relations may be deduced from the stress-strain curves of sand drawn in Fig. 4. Compressing a mass of sand held in a rigid ring gives a stress-strain curve like the full line. The lateral pressure is smaller than the vertical pressure (load pressure) within the sand, and corresponds to earth pressure at rest. From the full-line curve can be derived (by the use of Poisson's ratio) the curve of cubical compression, representing the strain-effect of pressure equal in all directions (and therefore comparable to a capillary pressure); this is shown by a dash line. Suppose, now, the compression process represented by this dash curve be stopped at pressure p_1. Each element of the mass is now in the same condition as a clay cube subject to capillary pressure of the same amount p_1. Hence, if the sand specimen is further loaded in the vertical direction only, holding the lateral pressure constant at amount p_1 and allowing free lateral expansion to take place under the action of increased vertical load, we are bound to obtain a stress-strain curve identical with that of a vertically loaded clay cube. Two such curves are shown in Fig. 4, beginning at the respective cubical pressures p_1 and p_2; as the tests on clay cubes showed that the ratio between modulus of elasticity and internal pressure is constant, we may conclude that the slope of the hysteresis loops in these two curves will have the ratio $p_2:p_1$. In other words, all stress-strain curves of the type shown for the two free cubes in Fig. 4 will differ only in the scale of their abscissas; so that if curve p_1 was obtained in a test, the curve p_2 can be drawn by simply increasing the abscissas of p_1 in the proportion $p_2:p_1$. The truth of this statement was repeatedly checked by experiments on clay.

Clay and Sand Compared With Solids—In discussing the cohesion of clays I have previously shown that the ratio between the modulus of elasticity and the internal (intrinsic or molecular) pressure is a constant not only for clay but also for metals. Therefore *the laws expressed by Fig. 4 are approximately valid for the whole field of materials*, regardless of whether the particles of the material are kept together by molecular attraction (solids), by a capillary pressure (clays), or by the pressure due to the weight of the material itself (cohesionless sands).

Let us imagine for instance a cubical body consisting of cohesionless sand. From the tests already made we may calculate that an internal pressure of 1226 kg./cm.^{2} will bring the modulus of elasticity up to 200,000 kg./cm.^{2}. This value is approximately equal to the value of the modulus of elasticity of ordinary concrete. The compressive strength of the concrete, however, amounts to not more than 300 kg./cm.^{2}, while the cube of sand can carry a maximum load of about 10,000 kg./cm.^{2},

provided the internal pressure remains unchanged. For loads ranging between zero and 300 kg./cm.² the relations between stress and strain for sand agree far better with Hooke's law than do those for concrete. This statement may serve as one of the many examples of the fact that in solid bodies the ratio between compressive strength and intrinsic pressure is exceedingly small, compared to the corresponding ratio for aggregates of individual grains. Investigation of the physical causes of the low value of this ratio for solids represents one of the most attractive problems of modern research on resistance of materials.

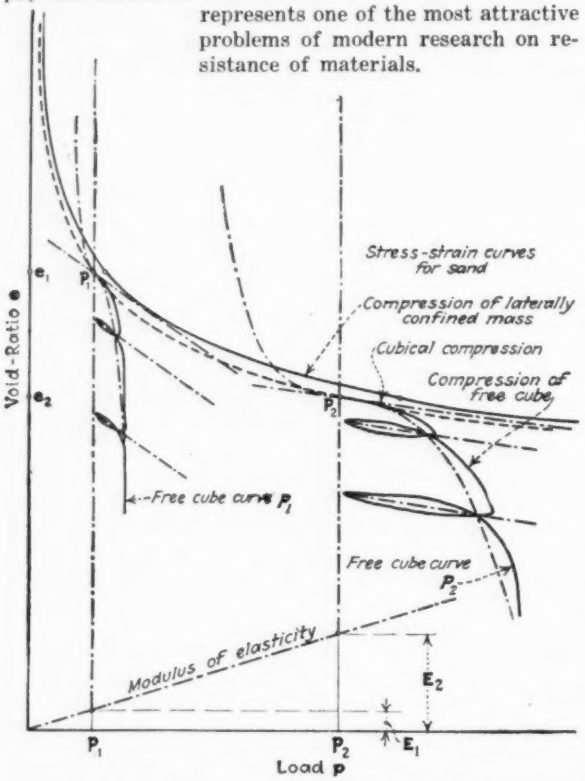


FIG. 4—STRESS-STRAIN DIAGRAM OF SAND

Due to the high ratio between modulus of elasticity and internal pressure for sands (from 238 to 419 for sands, against 31 for fat clays and about 10 for metals), a very small lateral expansion of the sand causes a considerable decrease of the lateral sand pressure. For this reason it is difficult to determine the value of earth pressure at rest, except by an indirect method such as used by the author (see "Old Earth-Pressure Theories," *Engineering News-Record*, Sept. 20, 1923, p. 632). Retaining-wall tests made by the hinged-gate method, on the other hand, are almost unavoidably affected by error because of the effect of lateral expansion.

SAND AND CLAY COMPARED AS TO PHYSICAL PHENOMENA AND THEIR CAUSES

Cause	Physical Factors Affected	Visible Consequence
Grain size.	Aggregate initial friction per unit of volume.	(1) Difference in maximum volume of voids: About 50 per cent for sand, about 98 per cent for clay.
	Capillary pressure and surface tension of the capillary water.	(2) Difference in shrinkage: Sand does not shrink in drying; clay shrinks.
		(3) Difference in cohesion: Clean sand is devoid of cohesion, clay has high cohesion.
Grain size and shape (grains bulky or scale-like).	Capillary pressure; nature of intergranular movements during deformation of the mass.	(4) Difference in plasticity: Sand is not plastic, clay is very plastic.
	Degree of permeability.	(5) Difference in speed of adjustment to loads: Sand when loaded settles to its final volume almost at once, while settlement of clay foundations proceeds very slowly.
Character of grains.	Flexibility of the particles.	(6) Difference in compressibility of the aggregate: Sand is far less compressible than clay.

Conclusions—The results of our comparison between the physical properties of sand and of clay are presented in the table. The facts stated in the first and last column of the table have long been known, but knowledge of the causative connection however between these two groups of facts is new. It is a much simpler connection than might have been expected. This table, the curves of Fig. 4, and the partial differential equation

$$\frac{K}{a} \cdot \frac{\delta^2 w}{\delta z^2} = \frac{\delta w}{\delta t}$$

represent the fundamental principles of soil mechanics in a nutshell. They are the key to the physical explanation of whatever properties a soil may display, in the laboratory or in the field.

Precast Concrete Units for Railway Structures

Varied Uses and Sizes—Bridge Decks—Building Blocks and Structural Parts—Piles, Poles and Track Signs

A REVIEW of the extensive and varied use of precast concrete units was the interesting subject of a report presented at the annual meeting of the American Railway Bridge and Building Association By T. H. Strate, engineer of track elevation of the Chicago, Milwaukee & St. Paul Ry. An abstract of this report is given below.

The use of precast concrete units offers a number of advantages to the railway engineer. There are large savings in the transportation of men and equipment, and a centrally located concreting plant may be better protected and maintained, with resulting longer life. There are equally important advantages as to quality, since a central plant permits better supervision and inspection. The repeated use of forms makes it possible to spend more money on them, with the result that truer and better surfaces and lines are secured. Equipment may be provided for measuring water and materials accurately. In field-mixed concrete, the tendency is to use as small a mixer as possible, but in a central plant a mixer with ample capacity may be provided, which will reduce the tendency to cut down the time of mixing. All of these factors contribute to the ease with which a uniformly high quality of concrete may be secured.

A railway concrete products plant may be so managed as to stabilize employment, for with a plant making standardized units which may be stored till needed, the men may be kept busy profitably and a better class of workmen thus secured and retained. Work on the smaller units may be carried on under cover throughout the most severe weather, and arrangements for protecting even the larger units are much simpler in a central plant than in isolated locations. Precast bridge slabs are probably the largest units commonly used. When these are cast on the ground they may be covered and protected much more easily than if cast in place at a point distant from a steam supply. Heating of the aggregates and mixing water also is much easier.

Bridges—Precast bridge slabs are used to some extent by practically all of the larger roads. The outstanding advantage is the minimum of interference with traffic during construction, since the units may be subjected to full loads immediately. On a road of two or more tracks,

slabs for one track may be placed at a time, and even a single-track structure may be placed in the intervals between trains. The width of slabs is usually half the distance between center lines of adjacent tracks, but where the span is short and powerful erecting equipment is available, slabs of a width equal to the track spacing have been used.

Ordinary pile trestle slabs are usually of 14 to 18 ft. span. For street crossings and other places where longer spans are required 30-ft. slabs are not extreme. Slabs weighing 50 to 60 tons are handled successfully. To keep down the thickness and weight of such slabs, compression reinforcement is often used. Higher working stresses in the concrete will eliminate the necessity of that steel and in many cases will permit the use of thinner slabs. Experience on a number of railway concrete jobs has proved that it is a simple matter to produce concrete with a uniform strength exceeding 3,000 lb. per sq.in. in compression in 28 days.

Precast units are used to some extent to replace, piece by piece, old timber structures as they decay. This work is done by the bridge-and-building forces and the units are kept as small as possible to facilitate handling without calling for heavy equipment. Probably the most common are small concrete piers or footings to replace wooden sills, which are the first part of a timber bent to decay.

Piles—Precast piles may be of any section and the length is limited only by facilities for handling. Sometimes they are equipped with jets for sinking, but hammering is the usual method and the amount of driving a pile will take without damage is surprising. Piles 60 to 70 ft. in length are common and there are examples of 120-ft. piles. In handling the greater lengths, it is necessary to attach leads to several points in order to avoid excessive bending stresses. In cross-section, piles range up to 2 ft. square. It is often the practice to cut away the concrete to expose the steel reinforcing, which is then bent over into the cap.

Railings—Even on cast-in-place bridges, it is often convenient to use precast railings or at least precast facings for railings. There seems to be a tendency toward using light sections for bridge railings, with the reinforcing steel insufficiently covered with concrete of poor quality. This is doubtless due to the thought that the stresses on the units are small, which is true. But it ignores the fact that these light units are in an extremely exposed position and subjected to the most severe weathering.

Pipe—Some of the larger roads manufacture their own pipe. Others have abandoned this practice as manufacturing companies can furnish a high quality pipe. Such pipe is available in sizes up to 84 in. in diameter, although the smaller sizes are more general. Whether pipe is purchased or manufactured care should be taken to see that a high quality concrete is used, with sufficient reinforcing, securely anchored to insure correct spacing.

Buildings—Small railway buildings are a real problem as to economical construction. Watchmen's shanties, telephone booths, shelters at way stations, oil and tool houses, yard offices, snowsheds and structures for electric connections are a few of the buildings which may be cast as units and transported to the site ready for use.

Larger buildings may be cast in units or sections and assembled. This practice seems specially advantageous for engine houses, where there are a number of stalls all alike, requiring a number of units which may be cast in one set of forms. Each unit is so designed that a portion of the reinforcement is left projecting, so as to be used later to tie the unit to adjacent units by placing mortar around the projections. Besides economy, an advantage of unit construction is the speed with which a building may be erected. One type consists of verticals clamped together in such a way as to hold two thicknesses of slabs, with a 3-in. air space between.

Concrete blocks deserve more attention than they have received. For thin walls, concrete blocks are considerably cheaper than monolithic walls. Such walls rarely carry much load and a little care in selecting the blocks, if they are purchased, will insure a good quality. Although blocks will probably be more extensively used in smaller structures, their use in stations and freight houses is not uncommon. Different facing surfaces may be selected and further refinement is possible through the use of a stucco finish. Canopies are made of precast units. Precast curbing is being used in many cases for station platforms and around switchstands and water columns. Precast concrete sills and lintels are convenient for use in block walls and are reinforced to carry the loads.

Retaining Walls—Probably the most common form of retaining wall made up of precast units is the crib wall, consisting of stretchers and headers interlocked together. They require little foundation and may be laid up rapidly. A concrete crib wall is both permanent and portable and when placed on a new fill or unstable foundation its flexibility is an important advantage. Each end of each stretcher should be securely interlocked with the headers, as a wall with the stretchers anchored only in the middle has had a considerable number of broken units.

Another type of precast wall consists of large blocks which interlock together to form a gravity wall. The units were 8 ft. long, 2 ft. high and from 5 to 18 ft. wide. A third type of precast wall consists of concrete sheetpiles designed to interlock and in some cases to be tied back with steel rods. Such construction was used in the original Galveston causeway and withstood the action of the 1915 storm without damage, but the waves, passing completely over the causeway, washed out the fill between the two parallel walls and left them standing. A variation of this type is to drive piles at intervals and fit precast panels into grooves provided for that purpose in the sides of the piles. Where a wall of this type has sufficient strength it will be cheaper than a wall built entirely of sheetpiles. The panels may or may not be grouted into place.

Tunnel Lining—In relining a tunnel on the San Francisco-Sacramento Ry., precast ribs and slabs were used to replace the decayed timber. The ribs were spaced 3 to 4 ft. apart and precast slabs were made to fit in grooves on either side. Before placing the ribs and slabs, concrete sills were cast in place at foundations. This construction cost one-fourth less than monolithic lining actually placed in the same tunnel. It eliminated formwork in the tunnel, afforded opportunity for good concrete because cast in the open with time for curing and inspection, and it enabled the worst decayed portion of the tunnel to be replaced first.

Miscellaneous Units—Among the great variety of miscellaneous units adopted for railroad use, fence posts probably stand first in importance. These posts are square, triangular, round or of irregular shape, with many different arrangements for fastening wires. Whistle, sign and mile posts of concrete are standard practice on several roads. They are inexpensive and durable. The lettering is recessed and painted. Telegraph and telephone poles have been used less extensively on steam lines, but there are a few examples, all of which are favorable. Electric lines have used large numbers of them. The cost does not greatly exceed that of a treated wood pole. Concrete conduits for underground wires have proved quite successful by power companies.

Highway grade crossing slabs have been used with varying success. Concrete in such slabs is subjected to severe treatment and must be of high quality. Further, they must be given some attention and maintenance. The ratio of life of concrete and wood crossings has been given as 6 to 1. Even if cracking occurs, due to uneven bearing, the ballast will still be retained and the slab will serve its purpose. Concrete slabs for lining ore-dock pockets were originally designed because they last longer than wood, but it has developed that an even more im-

finish. Canopies are made of precast units. Precast curbing

The signal department uses concrete in relatively small quantities and there are numerous advantages in having the work centralized. Battery wells, signal bases, cable posts, trunking bases and the trunking itself are some of the units more often used. Water troughs for stock yards are standard on a number of railroads. The bases are cast separate from the trough. Concrete water barrels for fire protection are standard on at least two trunk line roads. Concrete ties are still in the experimental stage, but the biggest poblem is the design of a rail fastening that will be satisfactory. Other precast concrete units include rail carriers, manholes, roofing tile, chimneys, smoke-jacks for engine houses, terrazzo and colored tile floor sections, roof slabs, decorative wall panels, car wheel racks, cattle-guards, septic tanks and even flower pots for use around stations.

Road Progress in the South Atlantic and Gulf States

South Carolina	Louisiana
Georgia	Florida
Alabama	Mississippi

An Editorial Field Study of State Road Organization, Policies and Plans; the Trend of Highway Thinking; the Status of State Control; and the Progress in Engineering and Construction in Six Southern States

By John W. Shaver
Assistant Editor, *Engineering News-Record*

III—Alabama

When the law authorizing the establishment of the Alabama State Highway Commission was passed in 1911 the only provision made for financing was the authorization of an annual sum of $10,000, with an additional amount if circumstances demanded it, to pay the salary of the state highway engineer, his assistants and office expense. No money was provided for either state construction or maintenance. That first law became operative April 1, 1911. W. S. Keller was the first highway engineer appointed and he held that office continuously from the organization of the highway department until his death a few months ago. However, in the meantime the organization was greatly enlarged and considerable financial assistance given the department for construction, particularly. Another pioneer in the department is W. P. Boyd, who went to the office of assistant to Mr. Keller upon the department's organization. Mr. Boyd has been recently made commissioner in charge of maintenance.

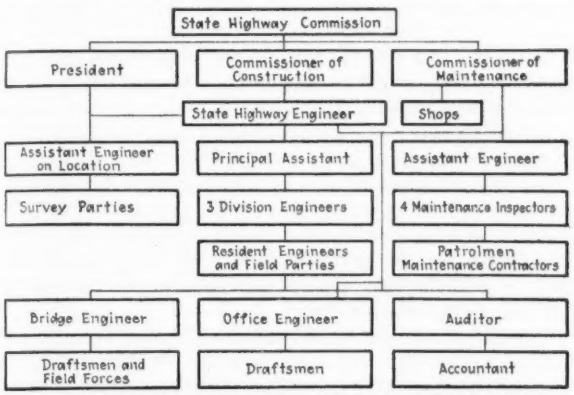
Beginning of System—That first commission was made up of five members, three of whom were appointees of the governor, the other two being the head of the engineering department at Auburn College and the state geologist. The sum of $2,000 was authorized for expenditure in each of the counties yearly for road work, providing the county matched the funds. As there are 67 counties in the state this made a total appropriation each year of $134,000, the entire sum to be taken from the convict fund. The state money could be taken up by the counties, if they so chose, at two-year intervals, the appropriation then amounting to $4,000 biennially from the state. In a good many instances none of the money was requested by the counties. This unexpended balance was then pro-rated among those counties that actually were doing road work, so that in many years the annual state aid for county highway construction amounted to around $3,000. Such assistance allowed the counties to start on the construction of highways of intrastate importance, with the state highway commission wielding some authority as to the type of road constructed and the project upon which the money was spent. This first highway organization was largely educational, and was designed to begin in a meager way the construction of a state system. The educational effects were beneficial, and after federal aid became available in 1916 the state was farther along in state road building than many of the other southern states. A tentative system of state highways was laid out by the original commission and approved in 1915. Little change has been made in that system, though a few roads have been abandoned and others added.

At the time federal aid became available the governor exercised his right to add an additional $10,000 for highway department operation, though no provision was made for either construction or maintenance money that should be the state's own fund. To match federal-aid funds the counties took the $2,000 yearly allowed by the state, put it with their own funds, and then began the construction of federal-aid projects. As no adequate financial provision was made for engineering services, what was known as the "project plan" was followed: that is, the resident engineers had to depend upon the work actually done for the counties for their remuneration. The original law called for a flat $5 a day rate for such engineering service, with commensurate pay for other members of field and office parties. Incidentally with this system in operation it often happened that project engineers had to depend on half a dozen counties for their pay, which at times was difficult to collect. However, a considerable mileage of roads on principal state routes was thus constructed, though the greater percentage was semi-hard paving, mostly chert and gravel. With federal aid available yearly in amounts exceeding $1,000,000 counties began to become more keenly interested in highway construction, and interest-bearing warrants were frequently issued for general road improvement. Some of these warrants ran as high as a quarter of a million dollars. Though considerable construction was thus carried on the counties failed to give the roads the proper maintenance. The state required maintenance on state roads, and the federal-aid projects were required to be properly maintained, but the county roads that actually might be connecting links in federal-aid and state routes often suffered through improper or total lack of maintenance. This short-sighted policy on the counties' part has had considerable effect on the present condition of the state's system.

Not until 1919 was the state highway department actually provided for financially, aside from a flat $20,000 yearly appropriation for engineering and office expense. At that time the legislature diverted 80 per cent of the motor vehicle tax to the general fund to be put to the credit of the state highway department. The other 20 per cent was retained by the municipalities and the counties collecting the tax. This provision went into effect Oct. 1, 1919. At the same time the constitution was amended to allow submission to the people of a measure proposing the raising of $25,000,000 in bonds for road construction. The bond issue passed by about an eight-to-one vote in November of 1919, but, due to the fact that the constitutional provisions for holding referendum elections had not been

strictly adhered to, the supreme court decided that the bond issue was unconstitutional. The highway department therefore had to carry on with only its motor vehicle tax money until early in 1922 when the bond issue amendment was resubmitted to the people and passed by as large a majority as it had carried the first time.

In October, 1919, the highway law was changed so that the commission was to be composed of twelve members, one from each of the congressional districts with two ex-officio members—the state geologist and the head of engineering at Auburn. This commission was authorized to appoint the state highway engineer, and Mr. Keller continued in office. Also with the bond money available a larger organization was necessary. The new technical supervisory force was built to include four division engineers, a locating engineer, and office engineer, bridge engineer, and the various necessary



ORGANIZATION OF STATE HIGHWAY PERSONNEL IN ALABAMA

sub-force of field and office men. Practically the same personnel is maintained now as comprised that organization, with the exception of the fact that now division engineers have nothing to do with maintenance, and there are three divisions instead of four. The exact existing organization of the department is given in the chart herewith reproduced.

Present Status—The highway commission itself was reconstituted in 1923. Instead of its containing twelve members the law was changed to revert to a smaller board, though this time it was but a three-man board. No restrictions were imposed as to who those three should be, but one was to be known as president of the commission and the other two as associates, one of them in charge of maintenance and the other construction.

The department has but recently been involved in some political difficulties, which, it is now hoped, have been entirely overcome. At the death of Mr. Keller in September the governor wanted to have appointed as his successor Col. W. A. McCalla, the principal assistant engineer, who had been with the department a number of years. The two associate members of the commission opposed this plan, and made public material out of their opposition. As a result Governor Brandon deposed those two members of the commission and appointed two engineers from the department as their successors. Thus the commission is now composed of a lay member as president, and two engineers, one of them commissioner of maintenance and the other commissioner of construction. With such a commission, Alabama has greater direct technical control over its highways from the administrative side than any of the other southern states. Colonel McCalla has since been made the state highway engineer. The coming gubernatorial election, however, threatens to reawaken a certain amount of the recent trouble, for an opponent of the incumbent for governor has announced as one of his proposed policies the return of the highway commission to a 12-man body. It is doubtful that such a return to the more unwieldy organization can be made.

There was proposed in 1923 a gasoline tax for the exclusive use of the state highway department. The bill was introduced into the state legislature, but after the senate had finished with it only half of the tax money was to be given the state highway department. When the house had amended the bill all of the money was to be returned to the counties for their use. The bill passed in that form, so the state roads benefit only indirectly by the tax on gasoline.

When the $25,000,000 bond issue became available in January, 1922, the state embarked on a more extensive road-building program. The motor-vehicle taxes were restricted to be used for interest on the bonds and their retirement and for maintenance. Inasmuch as the net receipts of that tax to the department have ranged from about $835,000 in 1920 to almost $2,000,000 this year, it is seen that entirely inadequate funds remain for maintenance. This lack of funds has had a decided effect on state road maintenance. In short, the state highway department maintains only those roads which it constructs. With a mileage at the present of around 4,000 miles in the state system, but little more than 1,500 miles or about 37½ per cent, are under constant maintenance. There are 1,417 miles in the state system completed and 691 under construction. The difference between the roads completed and those under maintenance is made up of highways which the counties have built on the state system which the state must maintain. Such a system of maintenance, it is easy to see, results in a spotted mileage of good roads. One may travel over several sections (the most used ones and usually connecting towns) of an intrastate highway and meet some of the best and some of the worst road conditions. The traveler may ride over a concrete road for a number of miles and then come to a dirt road that has no maintenance whatsoever. The obvious answer to such conditions is enough money with which to keep the entire state road system under maintenance. As an indication of what the department thinks of the present lack of maintenance money, the following report by R. P. Boyd, commissioner of maintenance, to the governor and submitted in late October, is given in abstract form:

If all the roads that have been constructed in this state by the counties had been properly maintained there would to day be hundreds of miles in good condition, that, with a small expenditure for betterment work, would serve the present-day traffic. This, however, has not been the case except in a few counties, and now the state is rebuilding roads where very little of the first work is of advantage because of this neglect.

One of the wisest provisions of the federal-aid act granting federal aid to the state in the construction of roads was to provide that they should be maintained. All completed federal-aid projects are inspected regularly and their condition reported to the Bureau of Public Roads at Washington. To enforce this provision, the Department of Agriculture may withhold federal funds from construction work from any state that fails to maintain its completed projects. No federal aid is granted for maintenance of roads and the states must provide the necessary funds.

In this state, the motor vehicle license tax is used to pay interest and sinking fund on outstanding bonds and the support of the highway department, and the balance is used on maintenance. None of the present gas tax goes to the state for any purpose.

"Any highway program that does not provide wisely and adequately for maintenance is doomed to failure.

Some of the states maintain their entire road system, keeping the unconstructed section in fair condition. Alabama, due to lack of funds, has not been able to do maintenance on unconstructed sections.

At present, the state is maintaining approximately 37½ per cent of the 4,000 miles known as the seven per cent system, all of which is completed road."

Present Maintenance Methods—Under the supervisory organization effected in 1920 the state was divided into four construction divisions, though there are but three now. At that time also all maintenance was under the division engineers. It is now directly handled by the maintenance engineer in the Montgomery office, and the state is divided into four maintenance divisions.

Two kinds of maintenance are followed at the present: that done by patrols and that done under the contract system. Under the contract system the state lets a contract at a stipulated price per mile per year, the contractor furnishing all equipment, such as teams, trucks, etc., and all labor. Material needed for maintenance is furnished by the state. Only a small percentage of the maintenance is done under the contract system, because in only a few cases are there responsible contractors equipped for the work. It is more or less impossible to put into a maintenance contract everything that may have to be done, and at the price which the state can afford to pay the profit to the contractor is small. The work of maintenance under contract is usually not so good as that done by patrols.

The state pays the patrolman from $75 to $100 a month, depending upon the length of the section and the type of work. The state furnishes all equipment and labor. One patrolman may have from one to three sections under him, with the needed equipment and men. A section is from 10 to 15 miles, depending upon the type of road and the traffic. The patrol consists of one patrolman and two helpers. On sand-clay, gravel and chert roads each section requires a truck capable of hauling a road machine, or a tractor and a truck, a road machine, a drag and small tools, representing a cost of about $135 to $200 per mile for equipment.

The patrolman is required to keep a time report of all work and of its character. These reports are sent to the general office weekly with all bills for labor, gas, oil, etc. They are then prorated and posted under the proper item for each section. These items are: Right-of-way; ditches; culverts and bridges; shoulders and slopes, and surface. If local sand-clay or gravel pits are available they are used in replacing and patching. If material has to be shipped into the vicinity the state maintains stockpiles at convenient points. These are replenished so that maintenance work does not have to wait on materials.

Road Types—By far the largest mileage yet constructed has been sand-clay, top-soil, gravel and chert. These types are usually bunched into two types: (1) sand-clay and top-soil and (2) gravel and chert. The present mileage of constructed roads, amounting to a little more than 1,500 miles, contains 421 miles of the former type and 879 miles of gravel and chert. The sand-clay and top-soil roads are graded and drained and the top material spread to a thickness varying from 4 in. at the shoulders to 10 at the center. These roads are usually built in 24- and 26-ft. widths. For gravel and chert roads the same base preparation is given the road as for top-soil and sand-clay. Gravel is spread to an average loose depth of 9 in. These roads are usually constructed in 16- and 18-ft. widths. There are numerous sections of the state well supplied with both chert and gravel, so local materials reduce the cost of these roads considerably.

There are four or five types of hard pavements considered when paving contracts are called for. These are cement, concrete with the 9-6-9-in. section; sheet asphalt laid on an 8-5-8-in. concrete base; rock asphalt with a 1¾-in. top laid on a concrete base; and brick on concrete base. The four first-named are considered as competitive materials, and the best bid for any type is generally accepted. Bids are also taken at times on 2½-in. penetration macadam on 8-in. waterbound macadam base and on two-course rock asphalt on the same base.

With the last of the $25,000,000 bond issue hypothecated for next year's construction, the state faces lack of money to carry on its construction program. The last legislature made no provision for carrying on the work after the present money is exhausted. With that in mind good-roads advocates have appealed to the governor to call an extra session of the legislature to consider a constitutional amendment which would allow submission to the people this winter of a road bond issue of $75,000,000. So far the governor has made no decision in the matter.

The outstanding difficulty which Alabama faces is the lack of funds with which to operate. Particularly does this affect maintenance. The report of the commissioner of maintenance shows that but $260,000 was available for such uses from October, 1923, to October, 1924. During that same period ending in October, 1925, there was available $200,000 more. Another hundred thousand it is expected will be added during 1926. But that is a small sum to maintain a state system. It is also true that more construction money is needed. For bridges it has been estimated that $15,000,000 will be necessary to reconstruct or rehabilitate bridges on the state system alone. Incidentally there are ten rivers in the state considered navigable for a large per cent of total mileage, to say nothing of the multitudinous smaller waterways. Alabama needs road money. The only question is how that money can be best raised to serve the state's general economic interests.

New Service to Protect Forests

Emergency forest-fire crews are a new feature of the Forest Service protective organization in the Pacific northwest, according to the Forest Service, U. S. Department of Agriculture. A crew consists of 1 forest-fire chief, 2 or 3 fire foremen, 1 camp superintendent, and 1 cook. They are located at strategic points in the forest-fire regions and will be used only to direct the work on large fires. Each squadron is supplied with motor transport for a quick get-away and is in telephone communication with the forest supervisor's headquarters. During the time they are not actually needed on forest fires they work on road and bridge building and other improvements. The fire chiefs are all regular forest rangers with many years' experience in handling large forest fires. The other members of the squadrons are local residents who have had extensive experience in forest-fire fighting.

Concrete Improved by the Use of Diatomaceous Earth

Tests by North Carolina Highway Department Show Strength and Workability Increased With Included Celite

By C. N. Conner
State Construction Engineer, North Carolina State Highway Commission, Raleigh, N. C.

LABORATORY tests of 6 x 12-in. concrete cylinders broken in compression over periods up to one year by the North Carolina State Highway Commission tend to show that diatomaceous earth included in the mix increases strength and promotes workability. In the past test cores drilled from concrete pavements have proved that much is to be gained by the use of any practical means to reduce the variation in strength existing in the finished concrete. Such tests also indicate that considerable of this variation is due to segregation caused by the manipulation in placing the concrete. The increased workability secured by the U. S. Bureau of Standards using diatomaceous earth as an admixture led the North Carolina commission to carry on an extensive investigation of the effect of this material on the strength and uniformity of concrete mixtures.

The diatomaceous earth used was an especially prepared material known commercially as celite. It is the Plankton Marine type, the same as that used by Messrs. Pearson and Hitchcock (U. S. Bureau of Standards) in their investigation of the effect of powdered admixtures on the workability of concrete reported in *Proceedings* of the American Concrete Institute, 1924.

The laboratory program included tests of over two thousand 6 x 12-in. concrete specimens. The tests up to one year are available at this time. The results of the tests for both 28 days and one year are compared with those for plain concrete in the diagram, in which the plain concrete is taken at 100 at each age.

The average increase in the compressive strength of concrete containing various percentages of celite, compared with plain concrete, was 3 per cent at the 28-day age and 8 per cent at one year. All laboratory tests were made on concrete of equal consistencies. The increased workability of the concrete, when celite is used, permits the use of dryer consistencies in field concrete. This would be more favorable toward increased strength and uniformity than is secured by laboratory tests. Field investigations of celite, as determined by tests of cores cut from the pavement, indicate an increase of about 10 per cent in the strength of specimens having an average age of five months.

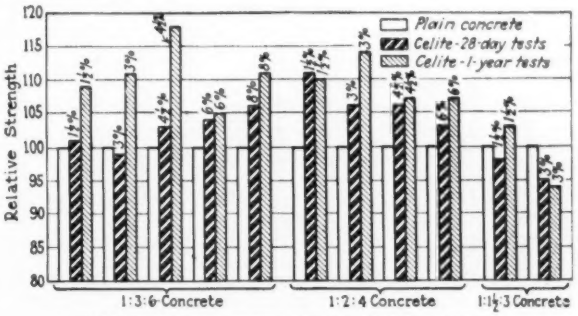
The increase in relative strength of the concrete containing celite over plain mixtures, between the 28-day and one year period, ranges from 2 to 15 per cent.

AVERAGE COMPRESSIVE TEST RESULTS

	Cement —15 Per Cent—		Cement —20 Per Cent—		Cement —25 Per Cent—	
	28-Da.	1 Yr.	28-Da.	1 Yr.	28-Da.	1 Yr.
Plain concrete per cent....	100	100	100	100	100	100
1½ per cent Celite						
Per cent of plain concrete...	101	109	111	110	98	103
3 per cent Celite						
Per cent of plain concrete...	99	111	106	114	95	94
4½ per cent Celite						
Per cent of plain concrete...	103	118	106	107		
6 per cent Celite						
Per cent of plain concrete...	104	105	103	107		
8 per cent Celite						
Per cent of plain concrete...	106	111				

The average increase of all mixtures is five per cent. Nine of the eleven series of tests show an increase of relative strength with age. Such increase in relative strength is of interest in connection with questions which might be raised regarding the effect of siliceous admixtures on the permanence of concrete. The results appear, to bear out contentions of earlier authorities that addition of finely divided silica is of benefit to cement mixtures. From the physical tests there is evidence of a combination between the free lime in the cement and the celite or amorphous silica.

Investigations of cores drilled from plain concrete pavements indicate that the concrete at the edges varies considerably more in quality than that in the center, although the average strength might be the same. It was assumed that this difference is due to the greater amount of handling necessary to get the edge concrete



COMPRESSIVE TESTS OF CONCRETE WITH CELITE ADMIXTURE

Each result is an average of ten specimens, five cured in damp closet and five cured in laboratory, 6 x 12 in. cylinders—age: 28 days and 1 year. 100 per cent concrete based on strength of plain concrete cylinders tested at respective ages. The per cent of celite is noted at the top of the column.

in place properly. A comparison of cores taken from edges of pavements under investigation shows that the mean variation in the plain concrete is about 60 per cent greater than that containing celite.

Records of projects upon which this material had been used show that increased yield of concrete is obtained. On one project in particular, where accurate records were kept, additional yield, as well as a quicker discharge from the mixer, was reported. When compared with, adjacent portions of plain concrete pavement, the contractor's records showed lower operating cost with celite.

Specification for Diatomaceous Earth—The result of these investigations justified calling for an approved form of diatomaceous earth in the 1925 state highway specifications on an alternate bid basis. Diatomaceous earth, in order to be approved, must meet the following requirements:

Diatomaceous earth for use in concrete or hydraulic cement compositions shall be finely divided Plankton Marine diatomaceous earth free from clay and crystalline silica and shall conform to the following requirements:

Not more than 1 per cent by weight of the material shall be retained on a 30-mesh screen.

Not more than 15 per cent by weight of the material shall be retained on a 200-mesh screen.

Settling tests with distilled water shall show not less than 55 per cent of the material remaining in suspension.

The material shall not contain more than 10 per cent by weight of moisture.

A moisture-free sample of the material shall not show a loss on ignition at 1,800 deg. F. of more than 6 per cent. An ignited sample shall contain at least 92 per cent of silica and not over 4 per cent of alumina.

The specifications call for: 2 per cent in 1:1½:3 concrete; 3 per cent in 1:2:4 concrete; 4 per cent in 1:2½:5 concrete (gravel coarse aggregate); and 5 per cent in 1:2½:5 concrete (crushed stone or slag coarse aggregate). These percentages are by weight of the cement content.

We have not as yet reached the ideal in concrete proportioning. We are limited in our design by the lack of workability in the more economic mixtures. The use of over-sanded mixtures has become popular as a means to secure workability. They furnish workability to a certain extent, but sand lacks in unit effectiveness and sacrifices density and strength both of which are important. Over-sanded mixtures also do not appear to increase the uniformity of field concrete.

If it is possible to employ additional means to improve workablity in field concrete and work toward the use of greater amounts of the coarser aggregate and less of the finer, with a given cement content, we can obtain a stronger, denser concrete possessing greater uniformity. It seems logical, from data now available, that the use of properly prepared diatomaceous earth should be considered seriously as means to this end.

Building 29-Ft. Concrete Arch Sewer at Richmond, Va.

Heavy Invert for Flat Arch—Tile Liners—Deep Trench Dug in Three Lifts

SHOCKOE CREEK sewer construction in Richmond, Va., a portion of which, constructed by city forces, was described in *Engineering News-Record*, Dec. 4, 1924, p. 900, is proceeding with the building by contract of two remarkably large arch sections aggregating about 8,100 ft. The portion built by city forces, about 1,700 ft., was a 15½ to 17 ft. x 11¾-ft. box section with a flat top and a dished bottom. A portion of the contract work, 534 ft., is 17 x 11¾-ft. box section but the remaining 7,500 ft., upward, is arch section of the type shown by Fig. 1. The contractors are Smith Bros., Inc., Dallas, Tex., for the box portion and 2,262 ft., of 27 x 15 ft. 1½-in. arch, and the Whiting Turner Construction Co., Baltimore, Md., for 2,535 ft. of 29 x 16¼-ft. arch and 2,769 ft. of 27 ft. x 15 ft. 1½-in. arch. Fig. 1 shows a section of the wider arch, one of the largest arch sewers ever built. Features of this operation only are described here. The conditions prompting the improvement and the initial plan were described in *Engineering News-Record*, Sept. 14, 1917, but changes in structure have since been made.

To sum up, the present Shockoe Creek sewer has the following lengths and sections:

Sections	Lengths
29 x 16¼-ft. arch	2,535 ft.
27 x 15 ft. 1½-in. arch	5,100 ft.
18½ x 10-ft. arch	1,400 ft.
15 x 9-ft. arch	1,600 ft.
60-in. circular	200 ft.
15 to 17½ x 11¾-ft. box	2,250 ft.
Total length	13,085 ft.

The specific work being described comprises all the 29-ft. arch and part of the 27-ft. arch. The 29-ft. arch section, Fig. 1, has a rather flat arch because of limited head room and this called for a more than commonly heavy invert and well tied-in reinforcement as indicated by the drawing Fig. 1, and the invert view Fig. 2. A

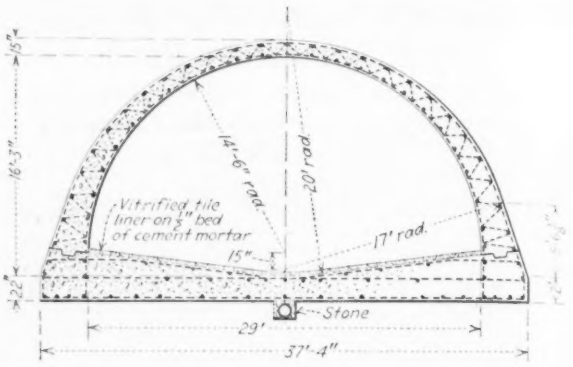


FIG. 1—MAXIMUM SECTION FOR SHOCKOE CREEK SEWER
Limited head room made flat arch necessary. Note heavy invert and reinforcing. Vitrified tile paving on invert.

feature of the invert is the paving of vitrified clay liner plates 9 x 18 x 1½-in., with ribbed backs to bond them into the ½-in. mortar coat in which they are set on the invert.

There are in the Whiting Turner Construction Co. contract 168,000 cu.yd. of excavation and 45,000 cu.yd. of concrete with 1,700 tons of reinforcing steel. The plant for this work includes two crawler-traction revolving steam shovels, models 21 and 37, both equipped with high lift booms and the smaller also equipped for dragline work. Eight dinkeys are in use: four 18-ton, one 21-ton, two 16-ton, and one 12-ton. Other equipment includes 38 4-cu.yd. dump cars, twelve 3-cu.yd. concrete cars, a central concrete mixing plant with electric derrick, steel bins and hoppers, and a 1-cu.yd. tilting mixer. Miscellaneous equipment includes pumps, compressors, and hoisting engines. Three miles of railroad tracks are being used on this work. In general the procedure is to excavate trench with steam shovel, Fig. 3, loading into trains on a service railway along the bank. This railway also brings in the concrete from the central mixing plant.

Several interesting features developed as the construction progressed. For a considerable distance the

FIG. 2—ARCH BARS PROTRUDING FROM COMPLETED INVERT
Note trenching shovel loading spoil train ahead of completed invert. The thicket of projecting arch bars is well displayed in this view.

FIG. 3—STEAM SHOVEL DIGGING TRENCH
The track benches provided in excavating cuts of two or more lifts are well shown in this view. Note the top bench track indicated by spoil train on the left.

sewer followed the old creek bed, and in this section it was necessary to flume the water past the work, but as the creek drains the entire watershed of Richmond, every small rain drowned out the construction. For a period of several months last winter, about three days of actual work was all that could be accomplished in a week. The remaining four days were spent in cleaning up flood debris. In this particular section it was impossible to change the channel of the creek due to congestion on both sides. After this section was passed the construction met the old channel in only two places, and here the channel was changed with the smaller shovel and the danger of washouts lessened.

The excavation included a 40-ft. cut through Broad St., one of the principal thoroughfares of Richmond, and the passing under the street-car viaduct and the main line of the Seaboard Air Line Ry. The Broad St. cut was removed in three lifts. The first was made and then steel sheetpiling was driven to protect the other two cuts. The banks at this point were all filled ground and earth slides at each end of the piling were frequent. There were also electric and telephone cables, water and gas mains, through which service had to be maintained. This was accomplished by supporting them on cableways spanning the ditch.

Where the sewer crossed under the tracks of the Seaboard Air Line Ry., it was necessary to build a steel bridge, Fig. 4, to support the tracks. Pits were sunk 38 ft. below the top of rail and the concrete footings were placed 2 ft. below the subgrade of the sewer. On these footings the steel columns were set and the balance of the bridge erected.

Another feature of the construction was the underpinning of the buildings along the line and the street-car viaduct. The subgrade of the sewer under the viaduct was 20 ft. below the foundations, and many of the buildings had to be carried down 30 ft. Concrete piers and walls were used entirely for this work.

The entire excavation was dug by shovels and hauled by dinkeys and 4-cu.yd. dump cars. The excavation material was used for backfill on the completed work and in making fills for streets and other purposes in the immediate vicinity. No haul exceeded 3,000 ft. Where deep excavation was encountered the dirt was removed in two or more cuts, the track being laid on benches, the height suited to the lift of the shovel.

The concrete was mixed in a central mixing plant, located midway of the job. After mixing it was hauled by dinkeys pulling hopper concrete cars, Fig. 5. For the inverts 3-car trains were used and for the arches 2-car trains. The inverts were poured from the benches used for loading dirt and from the high banks, but in many places the banks were not high enough to pour the arches by chuting. This problem was solved by laying track on top of the sewer and pouring the arch from the top of the arch. The sections were 20½ ft. long and steel forms were used. Two 50-ft. timbers were used to span the distance from the steel center ahead of the one to be poured to the second arch back, Fig. 5. The track was then laid on these timbers and the concrete dumped directly into the forms. This method saved the rigging of chutes for the pour. One arch was poured every 24 hours, and every day the timbers were pulled ahead and enough track laid to pour another arch. Additional shores were placed under the steel forms on each side of the pour to prevent any undue strain being placed on the form. Each arch contained 64 cu.yd. and they have been poured in 1 hr. 45 min. but the average time is 2 hr. for a haul of 2,000 ft. each way. About 200 cu.yd. is the average day's pour. The lengths of the invert pours vary from 20 ft. to 40 ft., with 75 cu.yd. in a 20-ft. section.

The project is being carried out by the Department of Public Works of the city of Richmond, R. Keith Compton, director. The work for the contractor, the Whiting Turner Construction Co., is being directed by J. V. Walsh, superintendent, and L. N. Phillipy, assistant superintendent.

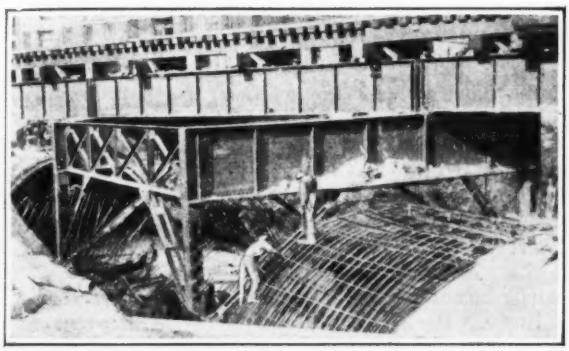


FIG. 4—BRIDGE SUPPORTING RAILWAY CROSSING SEWER
Legs of this bridge carried down 2 ft. below sewer subgrade or 38 ft. below base of rail. Bridge built ahead of trenching.

FIG. 5—CONCRETING 20½-FT. BAY OF SEWER
In places the trench banks were too low to permit pouring from spoil train tracks and a service railway was laid along the sewer top.

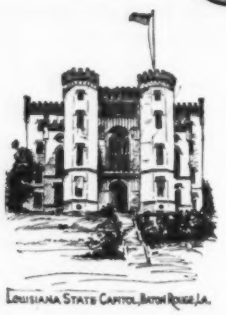
Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

Baton Rouge, La.



LOUISIANA STATE CAPITOL, BATON ROUGE, LA.

STATE CAPITAL OF LOUISIANA. Seventy-nine miles northwest of New Orleans, and well situated on the bluffs of the Mississippi River. The city is a port of entry and has a fine river harbor and a large shipping trade. Its manufacturing includes box factories, brickyards, sugar refineries, oil refineries, cotton and cottonseed oil and lumber mills. The state university of Louisiana and other educational institutions are located in Baton Rouge, also the state agricultural experiment station. The first settlement was made in the days of early French exploration. The city became the state capital in 1849. Pop. 1920, 22,000.

BATON ROUGE is the most southern of the Mississippi River cities which lie on high land. With its undulating topography it has excellent natural drainage. It is an industrial town, compact, clean, well-paved and comparatively rich. And though its engineering structures are either comparatively new or in thorough maintenance, the city does not employ, at the present time, a full-time city engineer. The greatest public-works development that has been carried on, and that within the past two years, has been under the supervision of a consulting engineering firm of New Orleans. However, the officers who control city affairs are fully aware of the necessity of competent engineering supervision and operation, and doubtless when the present development work is complete and the maintenance of engineering structures becomes conconsiderably more of a problem than it has been, a fully organized engineering office will be provided for.

The city has the commission form of government, each of the three commissioners (the mayor who is the commissioner of public health and safety, and commissioners of finance and parks and streets) is elected for a four-year term. Each is responsible for the personnel of his own office, who remain in office as long as they are satisfactory. Inasmuch as the commissioners and mayor are subject to recall by the general electorate and because the people have both initiative and referendum rights, the city government is pretty free of petty politics. Acts of individual commissioners which involve city policies are more or less supervised by the other two commissioners, the three sitting as a council. Thus there is a general interlocking of all municipal responsibilities. The commissioner of streets and parks supervises all of the engineering work save that concerned with water supply.

Until two years ago the city did have a full-time city engineer. However, when the large improvement project, upon which the city is now working, was about to get under way, he was dispensed with and the engineering work put in the hands of J. W. Billingsley, of New Orleans. The city has during that period paid for a share of the time of F. F. Pillet, a professor of engineering at the state university which is located at Baton Rouge. An assistant of Mr. Pillet's has been kept continuously employed in the city engineer's office, though neither he nor Mr. Pillet carried the title. The city will secure a city engineer on a full-time basis in the not too distant future.

There are a number of details of the city's operation which are striking. In the first place there is an atmosphere which surrounds the city offices that the municipality is really a commercial organization, though operating without profit. The commissioner of finance has been in that office for the past seventeen years and he has the history of the city's development and its present plant and works at the tip of his tongue. It is from him, L. J. Ricaud, that most of the information contained herein has been secured.

Street Services—One of the first things that one finds that interests the engineer is that the city is completely paved. The area of the city proper is but one and one-eighth square miles. It contains about 48 miles of streets. At least 85 per cent of this mileage is either paved with either brick or bitulithic, or is under construction or is of well-maintained gravel. There is not a block of earth roads within the city limits. Much of the paving (about $1,500,000 worth, chiefly bitulithic) has been laid in the past two years.

In 1923 the city made out an extensive program of public improvements that was to include $600,000 as the city's share in paving work. As the city pays one-third of paving work and the cost of laying intersections, and the abutting property pays the other two-thirds of paving, including curb and gutter work, but all of sidewalk costs, this $600,000 item meant a paving program of about $1,500,000. The bond issue, totaling $2,000,000, was approved by the people. Before the bond issue passed, the property owners had the right to object to any part of the projected paving work, which had been given free publicity, and showed where the hardsurfacing was to be done and where gravel was to be laid. Half the bonds were floated immediately and the paving work was started. However, when the first work was completed, there was such a clamor for all hardsurfacing that the city asked for an additional $200,000 for its share of the paving, which the voters readily allowed.

Other items included in that 1923 bond issue were:

For completing the sanitary sewer system	$325,000
For storm sewer drainage	325,000
For river terminals	350,000
To rebuild the entire fire alarm system, buy new equipment and build 4 new stations	175,000
To enlarge the facilities at the municipal slaughter house	45,000
Street opening and widening	35,000
Remodeling city hall	50,000
Developing public parks	75,000
For public library	20,000
For public library from a previous bond issue	35,000

The compactness of the city, which is practically square, presents an interesting study in municipal operation. The population of the city proper is about equaled by the population of the fringe communities. These are largely residential. They want admission

to the city so that adequate fire protection, sewer service, lighting and police protection will be given them. But the city so far has been unwilling to think of annexation. In the first place the sanitary sewer system was designed for a population occupying the present confines of the city, and annexation would mean the revision of the sanitary system with an expenditure of at least $1,000,000. Paving of annexed territory would mean another large sum and the general municipal expenses would soar with no commensurate revenue from newly-incorporated property.

But within its square-mile of territory, the city is completely paved, lighted, serviced with both storm-water drains and sanitary sewers, and has excellent fire and police protection. And the tax rate, with assessment this year of almost $36,000,000, is only seven mills for operating purposes and 4.3 mills for interest and principal of all outstanding bond issues. Also it is served with daily garbage collection (garbage is disposed of at two incinerators) except a few remote and sparsely settled sections which get collection every other day.

Though the city bears all of the expense of storm-water drains of 15-in. diameter and larger, the smaller sizes and all house connections for sanitary service are paid for by the abutting property. It is also required that connections with sanitary sewers be laid in advance of paving work. In sanitary sewer work, also, the city lays only the wye, and does not extend its service without cost as far as the curb, as is the case with so many municipalities.

Baton Rouge is one of the few cities so far found where bitulithic was the first pavement to be laid. The service has been excellent on this type, and practically the entire recently-inaugurated paving program has been bitulithic. When the present program is complete there will be around half a million yards of new bitulithic, with about 50,000 sq.yd. of brick. The bitulithic is 2 in. thick laid on a 5-in. concrete base. Monolithic curb and gutter sections prevail.

Though the property owners are allowed to pay for paving work in four annual installments, 20 per cent cash being required as soon as the street is accepted, approximately 35 per cent of all paving assessments so far have been entirely in cash, a fact which indicates in a measure the general presence of ready cash in the city. Even the colored population have money, and the commissioner of streets and parks has received petitions for paving work (and for hardsurfacing, not gravel) from entirely colored communities, where a good share of the money was paid in cash.

One of the most interesting of the city's activities concerns the ownership and operation of a public slaughter house. While not a direct engineering function of municipal administration the slaughter house, which is under the management of a federal inspector, has had a marked effect on the general health of the community. In 1915 the city made its first investment and installed a small plant. The capacity was doubled in 1917 and enlarged three years later. The 1923 bond issue included $45,000 appropriation for new installations, so that the city's investment in the slaughter house is $100,000. The plant is run without profit. Anyone can take cattle there to be killed. The charge per head for beeves, with lower scales for smaller animals, is $2.50, which includes six days' refrigeration and delivery to the block. The plant now has a business of more than 1,000 head monthly and contains refrigeration capacity for from 400 to 500 head.

Terminals—Both river and rail terminals in Baton Rouge are new. The Illinois Central has spent over $1,250,000 in a new passenger and freight terminal and in paving work in the past few years. It is said that Baton Rouge has the second best of the local terminals of the I.C. The city has appropriated $100,000 in addition to the $350,000 allotted by the 1923 bond issue for construction of river terminals, both for ocean-going vessels and barge traffic. The barges are to be accommodated at floating docks (the variation in river level being around 40 ft.) and construction of a 300-ft. concrete dock has been started for higher draft vessels.

About the only engineering difficulty which the city is troubled with at all is the disposition of storm water during high water in the Mississippi. During normal conditions storm water is discharged either into University Lake, and then spilled into the Mississippi, or is led in a southerly direction to waterways that eventually find their way into Lake Pontchartrain and the Gulf of Mexico. There are seven of these storm-water outfalls, three of them discharging directly into the lake. When the water in the Mississippi is 33 ft. or over the water from the lake must be pumped into the river. But that is infrequent. The river has reached a stage where the local gage reads 48 ft. The city is at an average elevation of 55 ft. but at such rises in the river part of the city would be inundated, without pumping. Sanitary sewage is discharged into the Mississippi through a single pumping station of four units, two of which are employed as standby plants. Pumping has to be done, however, only when the river gage reads 25 ft. or more. At normal stages of the river the entire sanitary sewer system is a gravity one. At high water stages these two pumps are at times taxed, for the infiltration water will make the flow five times the normal, but they carry it.

Water—The water supply of the city is entirely artesian. Water that can be delivered without filtration or treatment can be secured without pumping at depths ranging from 1,300 to 2,200 ft. Though enough wells have been sunk to care for normal needs of the city, until a few years ago there was no adequate peak provision for domestic consumption, industrial use and fire protection. The city induced the owners of the system to install pumping units. Water is available at only 800 ft. if pumped. Now adequate peak load demands for all uses are provided for. Two 1,500-g.p.m. electrical units have been installed, one a reserve unit. The other automatically takes care of peak loads so that the two 750,000-gal. reservoirs and a standpipe of 250,000 gal. are kept supplied.

The engineering structures of Baton Rouge appear to be entirely adequate to the present physical boundaries. But one other extension, in addition to the program under way, is contemplated. The two garbage incinerators now being operated are but 12-ton units and have been found too small. It is the present intention to enlarge the incinerating capacity with the addition of a 25-ton unit.

Though the city now is well serviced, if the pressure for annexation of fringe communities becomes too great, and the city is forced to supply services not now rendered, there will be considerable redesign of engineering installations.

Deterioration of Duralumin in the "Shenandoah"

Results of Bureau of Standards Tests Brought Out Before Court—Intercrystalline Corrosion Widespread

EXTENSIVE testimony on intercrystalline corrosion in the duralumin of the frame of the wrecked U. S. Navy dirigible "Shenandoah" and other specimens of duralumin, and on the resulting embrittlement and its relation to the strength of the airship, was brought out before the "Shenandoah" inquiry recently in the testimony of Dr. L. B. Tuckerman, of the Bureau of Standards. (A statement to the contrary in an editorial discussing this embrittlement, printed in our issue of Nov. 26, p. 862, was incorrect.) The testimony brings out clearly that corrosion was widespread, and that it caused definite, measurable embrittlement of the material, exhibited in a sharp reduction of ductility and of ability to stand bending without cracking. Dr. Tuckerman testified, however, that the embrittlement did not reduce the strength of the airship, as the unit stress in a compression member under ultimate load was less than the strength of the material after embrittlement. Essential extracts from the testimony (the total of which is too extensive to reproduce) are given below:

The tests made at the Bureau included 219 bend tests, 29 tensile tests, 20 repeated-bend tests on channel material, 49 tensile tests on lattices, various measurements of modulus of elasticity, micrographic examinations of 211 specimens selected from the presumed places of greatest corrosion, a number of fatigue tests of the duralumin, and several tensile tests on shear and netting wires, in addition to various minor items of testing. The wire tests showed uniformly high quality and do not figure further in the case.

Extract from Official Report of Bureau of Standards on Duralumin from Shenandoah:

"Intercrystalline corrosion of about the same extent as was observed in the investigation made for the Bureau of Aeronautics last spring was found to be general in the duralumin channels. This corrosion appeared to be distributed in random patches over the surfaces of the channels with no indication of especially severe attack in any special parts. In general the corroded patches formed only a small portion of the total area of the surface. The maximum depth of a corroded spot found was eight thousandths of an inch and on the average was from one to two thousandths of an inch.

". . . Of the tensile specimens, chosen from material presumably most severely corroded, one showed a tensile strength of 45,200 lb. per sq.in., while the others ranged from 53,500 to 63,200 lb. per sq.in. Bureau of Standards tests on comparable new material gave results varying from 55,000 to 65,000 lb. per sq.in. The percentage elongation in 2 in. varied from 5 to 17½ per cent, where comparable new material varied from 18 to 24 per cent.

"Intercrystalline corrosion was found in the lattices in smaller degree than in the channels. Corrosion of lattices from the 'Shenandoah' had not been found in the previous investigation, where fewer specimens were examined.

". . . Since the duralumin girders of the 'Shenandoah' were constructed so that they would fail by flexure within the elastic limit of the material without producing tensile stresses in any case of more than 36,050 lb. per sq.in., as found by tests, none of the material found in this thorough search had corroded sufficiently to lessen the resistance of the ship to static or aerodynamic forces.

"No results on fatigue tests of specimens from the wreck are as yet available, but tests on more severely corroded material from a scrap heap were made last spring. These tests were made at relatively high stress ranges and showed a lowering of the stress range which the material could endure for a given number of vibrations, to from 60 to 80 per cent of that for uncorroded material.

". . . These tests indicate that at the time of the wreck the corrosion of the duralumin in the 'Shenandoah' had not proceeded far enough to weaken the structure of the ship. It is evident, however, that the material itself was deteriorating and that in time the deterioration due to corrosion would have become so great as to render the ship useless. At the present time no method is known of preventing this corrosion; the protective coatings used merely delay its action.

"That the structure of the 'Shenandoah' was not weakened by the deterioration now present in the material, was due to the fact that its design did not utilize more than one-half the strength of the material.

". . . The previous investigations of the Bureau of Standards upon the material in the ship . . . consisted of the tests on the duralumin girders made for the Bureau of Aeronautics during the construction of the ship, the tests on fatigue of duralumin made for the Bureau of Aeronautics and the National Advisory Committee for Aeronautics during the years 1920 to 1925, the results of which are contained in the monthly reports of this investigation, and finally the investigation of corrosion of duralumin commenced last spring. . . . The tests on the girders had shown that 'the ultimate loads are determined solely by the modulus of elasticity of the material and the geometrical dimensions of the girders. The ultimate strength or yield-point of the material either in compression or tension have no influence on the strength so long as they are greater than the critical stresses.

". . . The investigation on fatigue had shown that when in good condition, fatigue failure of the ship need not be feared. On an assumed complete reversal of stresses of 10,000 lb. per sq.in., i.e., a range of stress of 20,000 lb. per sq.in., which is much greater than any range of vibratory stress that could reasonably be expected to exist in the ship, fatigue failure would not occur under 10 years (about 9,000 hours) of continuous flight at normal cruising speed. The investigation on corrosion had indicated that corrosion of an intercrystalline type such as has also been found by British investigators in duralumin of foreign makes occurred in the channels of the 'Shenandoah' when exposed to the weather but only infrequently if at all in the lattices. . . . This corrosion was most pronounced in unvarnished material fully exposed to the weather and less in the varnished material in the ship. It was accompanied by a slight decrease in strength, no reduction in yield-point and a considerable lowering of the elongation of the tensile test specimens. In cases where considerable corrosion was present there was a characteristic 'crazing' of the surface of the specimen. A more easily noticed effect was the increase of the radius of curvature at which cracks occurred in a bend specimen."

"A relatively few fatigue specimens of badly corroded material taken from a scrap heap had shown that at high stresses (range of stress change 35,000, or ± 17,500, to 50,000, or ±25,000 lb. per sq.in.) the corroded material was considerably less resistant to fatigue than new material, failure occurring at stress ranges varying from 60 to 80 per cent of those required to break the new material with the same number of alternations of stress, while one specimen withstood 14,431,000 alternations at a stress range of 27,000, or ± 13,600 lb. per sq.in."

Testimony of Dr. L. B. Tuckerman:

. . . Investigation was made of the rivets, and while corrosion was found on the heads of the rivets, it was never found in the shank of the rivets or under the rivets.

. . . Q. Is there any other form of deterioration besides intercrystalline corrosion to which you have referred in your previous answer, and if so, what is the influence of such corrosion on the properties of the material?

A. There is another type of corrosion which was familiar

to us before we commenced this study, and that is a pitting corrosion. The corrosion of the intercrystalline type is a weakening of the connections between the aluminum crystallines in the materials. The other is an eating away of the surface into pits, a complete eating away of the surface of the material, forming little pits like on a badly rusted piece of iron. You scrape it off and you see that it is pitted in pits. That apparently does not lower the elongation of the materials as much as the intercrystalline corrosion.

. . . Q. To what extent in your opinion might the embrittlement of the duralumin, as shown by test specimens from the wreck of the "Shenandoah," influence the strength of the ship?

A. It would not weaken the ship, in so far as static and aerodynamic loads are concerned. If any portion of the ship was subject to excessive or very large vibratory stresses, say of the order of 10,000 to 15,000 lb. per sq.in., a range of stress of 20,000 to 30,000 lb. per sq.in., it would weaken the ship materially.

. . . Q. You have explained that the strength of the ship is not reduced by intercrystalline corrosion under static and aerodynamic loading. Is the same true when the ship is exposed to impulsive forces which require that the structure shall absorb certain amounts of energy. Is not the resilience lowered by the reduction in alternate strength and ductility, and isn't it possible that for that reason the power of the ship to absorb shocks and impulses will be reduced;

A. That depends upon what the shock and what the impulse is. If I should take a corroded piece of material and strike it by a very sharp hammer or an axe, its resistance to such a blow would be reduced. But if I should strike it with a hammer enclosed in a piece of cloth wound around so that the shock was thereby softened or cushioned, I might strike it four or five times as hard a blow with that cushioned hammer and it would not break. Aerodynamic forces, no matter how impulsive they are, are cushioned much more by the very nature of air forces than I could obtain by any cushion of a hammer, and the impulsiveness of air forces, aerodynamic force, must be thought of as the impulsive force applied through a very resilient cushion. . . . If a portion of the ship had struck suddenly upon a hard surface, as upon the ground, I should expect that a blow of that kind would have found the ship considerably weaker because of the intercrystalline corrosion, but any force which the air would possible put on it—because the air is a cushion, that is all—though it may exert a very enormously great force, would not weaken it.

. . . Q. In your opinion is there any connection between the treatment of sheet duralumin in its manufacture and the subsequent tendency to corrosion? . . .

A. The investigation for the Bureau of Aeronautics and the National Advisory Committee and Army Air Service we hope will give an answer to that question. There seems to be some indication that if the material is cold-worked, after the last heat treatment, it renders it more liable to corrosion. Now, if that is so, then the stretching of the channels of the "Shenandoah," which we used to straighten them, increased the likelihood of the channels of the "Shenandoah" to corrosion. On the other hand, the lattices of the "Shenandoah" were also corroding, though not so rapidly, and they were heat-treated after the last cold-working. . . . The channels were heat-treated, and then before they aged they were rolled into shape, and then put into a machine and stretched from a quarter to a half of one per cent, just enough to make them straight.

. . . Q. Do your tests show that you can determine whether the life of an airship would be five or ten years?

A. No. The ship was safe the day she went down, as far as corrosion is concerned. Whether she would have been five years from now is not known.

. . . Q. As a result, Doctor, of your investigations on the material submitted to you from the "Shenandoah," in your opinion was the structure of the ship materially weaker than her designed and original strength?

A. No.

Zoning Decisions by British Ministry of Health

UNDER the British Housing and Town Planning Act, local authorities have extensive town planning powers, but are subject to the control of the Ministry of Health, both as to all stages of the rather elaborate planning procedure and on appeal of individual property owners. The following decisions on appeal are extracted from a summary based on the 1924-25 report of the Ministry of Health, given in the London Surveyor for Sept. 18:

Garage on Main Road Permitted—The erection of a large garage on a main road in a shopping and business area was permitted on condition that the garage be set back sufficiently to provide a standing place for vehicles and to avoid congestion of traffic on the road.

Erection of Shops Refused—An estate was acquired for residential development, the purchasers having obtained permission for the development pending the preparation and approval of the town planning scheme. Subsequently, when the bulk of the estate had already been sold off in building plots and dwelling houses erected, it was proposed to sell a site for a shopping center. It appeared that the erection of shops on the site in question was likely to depreciate the dwelling houses already erected, and permission for the erection of shops was refused.

Protection of Amenities of River—In connection with an application for permission for the erection of shops for the service of a residential district near a riverside, it was suggested that an agreement should be obtained for the maintenance of the premises in good order and condition so as to preserve the amenity of the aspect from the river.

Motor Omnibus Depot Disallowed—A responsible authority under an approved scheme proposed to consent to the erection of a motor omnibus depot on a site largely surrounded by small dwelling houses in a residential area. On appeal by neighboring owners and residents against the Authority's proposal to give consent it was considered that the erection of the building would be inimical to the amenity of these and other houses in the neighborhood, and it not being shown that suitable alternative sites could not be found, the proposal to assent was disallowed.

Extension of Existing Workshops Allowed—Permission was given for the extension of existing workshops belonging to an institution in a residential area. The land was in the possession of the institution and the existing workshops had been erected before the scheme under which the appeal was made came into operation, while the elevations of the proposed new buildings were not displeasing, and the processes to be carried on were innocuous. Conditions were attached to prevent the use of the building for noxious purposes and otherwise to protect the amenity of neighboring property.

Budget Provisions for Geological Survey

The budget which has just been submitted to Congress by the President carries a total of $1,796,000 for the Geological Survey, including $151,000 for stream gaging, for geological surveys $348,000, for topographical surveys, $437,000, and $97,000, for geologic maps.

Engineering Literature

A MONTHLY REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Drainage and Flood Control

REVIEWED BY ARTHUR E. MORGAN
President Dayton Morgan Engineering Co. and of Antioch College, Yellow Springs, Ohio

DRAINAGE AND FLOOD-CONTROL ENGINEERING — By George W. Pickels, C. E., Associate Professor of Drainage Engineering, University of Illinois, M. Am. Soc. C.E., M. A. S. T. M., M. Ill. Soc. Engrs., M. National Drainage Congress. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 450; 154 halftones and line cuts. $4.

In many respects our civilization is less than a hundred years old. When it comes to the application of scientific principles to the satisfaction of human needs, we find that some of the scientific principles involved, and to a far greater degree the orderly collection, assembly, and interpretation of comprehensive data, are a matter of very recent years. "Drainage and Flood-Control Engineering," by George W. Pickels, would have been impossible even thirty years ago. Here for the first time are gathered together in a reasonably ordered manner many of the data necessary for the intelligent planning of modern drainage and flood-control projects. When we compare this volume with Eliot's "Drainage Engineering," which was a classic in its day, we realize the remarkable advance that has been made.

The new book, in substance, is a compilation, but so organized and integrated as to make a consistent treatment of the subject as a whole. The introduction summarizes briefly the status of land drainage and flood-control, and is accompanied by pertinent statistics from the Census of 1920. The next five chapters deal with the hydrology and hydraulics of drainage and flood-control. Chapter VIII discussed the composition and characteristics of various classes of soil and their relation to drainage, and factors which affect the growth of plants. The next three chapters outline methods of design, laying out and construction of open channels, underdrain systems, and pumping plants for land drainage. There follow three chapters on as many methods of flood control, by channel improvement, levees and reservoirs. A chapter on excavating machinery gives brief descriptions and useful data on capacities and costs. The closing chapter, after referring to a few rules of common law, first gives an excellent outline of the successive steps commonly required under statute laws governing the organization and operation of drainage districts, after which there is a short but good discussion of assessment of benefits.

The author has adhered faithfully to his purpose of producing a textbook. The excellent selection of subject matter, logical arrangement in convenient sequence and interesting treatment in the form of condensed review, rather than an attempt at an exhaustive treatise, are well adapted to classroom use. While some portions may seem to lack interpretation or explanation of the practical application of the data presented, the author has worked under a severe limitation of space in covering the topics selected in a 440-p. volume, and it is fair to assume that instructors should be able to weave in any essential details not elaborated in the book.

Frequent references in the text, as well as in footnotes, are made to other published data on drainage and flood-control. This feature might well have been amplified in classified form under both subject and author headings, so as to provide the student with ready references to other valuable works that are generally available in the larger libraries. This would seem especially desirable when dealing with such subjects as hydrology and the hydraulics of stream flow.

It would be impossible to compile a work covering such a wide field without numerous errors in details or in inferences. On p. 2 Mr. Pickels says: "Fortunately, there are approximately 95,000,000 acres of swamp, overflowed, and tidal marsh lands yet to be reclaimed by drainage." Such statements are commonly made, especially in efforts to secure federal funds for drainage purposes. As a matter of fact a very large part of this land is so nearly valueless that its development under any conditions we now know would be an economic loss. Especially is this true of much of the Florida everglades, the largest body of undrained land within the United States.

On p. 47 the author states that all runoff factors can "be grouped under two heads: (1) precipitation; and (2) watershed characteristics." Almost as important as these is the element of weather. The same precipitation on the same watershed may produce a destructive flood in a period of wet weather or be almost harmless after a period of drought. There is only the barest mention of the effect of soil upon runoff, which is one of the chief factors to be considered. Rough mountain land in the Berkshires of Massachusetts, where the soil is sandy, will produce only a small fraction of the runoff for a given precipitation that will occur on the comparatively flat plain of central Ohio where the soil is clay and relatively impervious. This factor of soil has been generally underestimated by engineers.

On p. 55 there is a curious recrudescence of fundamentalism in the statement, "Streams have carved out their channels and flood plains to provide for their flood flows, and any encroachment by man in the way of levees, bridges, or buildings is naturally followed by more frequent flooding and greater flood heights, opinions to the contrary notwithstanding." In fact, the size of stream channels has no necessary relation whatever to the flood flow. The Hudson River below Albany has dug for itself a channel through the hills large enough to hold a hundred times the maximum flow, while the Coldwater River in Mississippi and the Little River through the flat land of southeastern Missouri, in their unimproved conditions, would carry only about 10 per cent of the maximum flood flow. Of course any encroachment upon the low lands over which flood water passes will cause a raising of the flood stage. No mention is made of ice gorges, a common cause of troublesome or disastrous floods on the rivers of Pennsylvania.

On p. 82 various curves are given indicating the runoff coefficients used on different projects. Among

these are coefficients developed by the writer for the Department of Agriculture and by the Morgan Engineering Co. It should be stated that these coefficients, while they were considered extreme at the time and went to the utmost extent then possible in providing adequate drainage, have nevertheless been found insufficient, and that in later work, since the partial development of these areas has made further investment in their reclamation possible, much larger coefficients of runoff have been used.

In the discussion of the flow of water in open channels, considerable space is given to several formulas which have largely passed out of use. Their mention is of value chiefly to let the reader know that the ground has been covered and that he is not missing something of importance in not using them.

On pp. 164-65, under the heading "Economics of Land Drainage," one factor has been omitted, just as it has frequently been omitted in practice, with the resulting loss of hundreds of thousands of dollars to investors in swamp land. That is the element of culture and custom in giving value to reclaimed land. A few years ago large amounts of money were spent in southern Louisiana in developing pumping projects. Every factor mentioned in the book was present—fertile land, feasible drainage, and the possibility of large crops under intelligent farming. All that was lacking was a population which would and could farm that particular land under those particular social and climatic conditions. Some of these tracts were settled by Iowa farmers. The farmers' wives found themselves in isolation surrounded by great tracts of waste land or living adjacent to simple and unlettered people. The farmers found themselves faced with the necessity of developing entirely new traditions and technique in agriculture. The result was an almost complete failure of this type of development, except for a few projects close to New Orleans. There are probably populations in India, southern China and the East Indies, which could make a great success of these tracts, but they are barred from entrance by the laws of our country. We may do well to have these lands as settlement reserves for our own people fifty or a hundred years hence.

In his discussion of detailed methods of land drainage, there is evidence that the author was chiefly acquainted with this type of work in Illinois and the immediately adjoining states, and is not familiar to any great extent with the great developments of the lower Mississippi valley. The suggested methods of making surveys would be inappropriate in the great flat tracts of the Mississippi delta. In those regions general surface topography should usually precede any attempt at location if good work is to be done, and the reviewer suspects that even in Illinois the habits of making careful topographic surveys, and of locating from those surveys, would be a very great improvement over the traditional method of locating channels. In this part of the book there is an implication of precision and finality in the discussion of details which is scarcely representative of the state of the art.

No mention is made of the possibility of making surveys by airplane. On large projects, airplane topography promises to be a very great boon to the engineer, as a map from surveys never quite translates all of the conditions.

Discussing the subject of drainage law, Mr. Pickels draws our attention to the distinction between the common law and the civil law basis of the treatment of water and water rights and responsibilities. Historically this distinction is clear but in fact neighboring states have so influenced each other's legal habits that the civil law and common law doctrines are gradually being made over and blended into what might be called "American law." This process has been going on for fifty years or more; the process perhaps began in Minnesota, where the old common law doctrine that water is a common enemy to be disposed of by every man as best he can was long ago modified by the provision that such action must be taken in a spirit of reasonableness and without undue or unnecessary damage to one's neighbor. Most of our states, with the possible exception of Louisiana, have made some sort of compromise between the two old doctrines.

Lack of space doubtless presented many difficulties to the author in condensing the data used and in satisfactorily separating details to be omitted. For instance, his description of some of the works of the Miami Conservancy District affords an excellent example of a retarding basin system, but it is apt to leave the reader with the impression that dams were the sole means of protection used, whereas the amount expended for channel improvement, levees and other protection works constituted more than a third of the combined cost. Failure to state its purpose may leave the erroneous inference that the project is one for the protection of agricultural lands.

To the practicing engineer an examination of the book is apt to leave a feeling of disappointment at not finding a more complete treatise. Much useful information has become available in recent years through research, investigation and construction experience on drainage and flood-control projects, and it is believed that a comprehensive compendium of these data in convenient form for reference would be welcomed by engineers engaged in this kind of work. It must be remembered, however, that the requirements of a textbook seldom admit of the complete compilation, detailed technical matter and fullness of reference to original sources that are desired by the experienced engineer, and the author has done well not to attempt the difficult task of producing a book to serve two purposes. In doing this he has also avoided needless elaboration and long theoretical discussions that frequently cumber books. He has rendered a most valuable service in collecting a judicious selection of subject matter from the many data available, and of presenting this in a most compact, clear, interesting and readable form. No previous book on the subject is comparable to this one in comprehensiveness or orderliness of presentation.

Contractors' Publicity

SELLING CONSTRUCTION SERVICE—By Charles F. Dingman, M. Am. Soc. C. E., M. A. S. M. E., M. New Jersey Society of Architects. New York and London: McGraw-Hill Book Co., Inc. Cloth; 4 x 7 in.; pp. 158; 37 fac-similes of advertisements and reproductions of letters. $2.50.

For the contractor who wants to know something of the publicity methods practicable for his use and to learn the elements of writing advertisements and sales letters and of preparing pamphlets describing work done, this little book contains much that is helpful. The chapters are: General principles, general advertising, examples of advertisements, use of calendars, blotters and novelties, sales letters and direct mail advertising, paper and stationery, mailing lists and personal solicitation. The treatment is elementary in character.

Gas and Electric Utility Problems

THE ECONOMICS OF PUBLIC UTILITIES: A Reference Book for Executives, Investors, Engineers and Students—By L. R. Nash, S.B., S.M., Public Utility Engineer, Stone & Webster, Inc., Sometime Lecturer at Massachusetts Institute of Technology, Harvard University and University Extension Division, Massachusetts Department of Education, Author of Sundry Monographs on Public Utility Problems and Development. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 430; 7 line cuts; list of Cases Cited. $4.

The author's own justification for adding another to the many books on the problems relating to privately owned public utilities is expressed in his Foreword as follows: "In his experience of more than 25 years in the business of designing, constructing and managing public utility properties, the author has often felt the need of a comprehensive book dealing with the broader business and economic problems of the industry." Some of these "broader" problems are treated more fully in this than in the earlier works, but for the most part Mr. Nash necessarily goes over familiar ground. He has the advantage, however, of saying the latest word on the many subjects in controversy and he is and long has been closer to the every-day problems of the utilities which he treats than have been most of his predecessors. He is also less partisan than some of the earlier writers who have represented the private-ownership viewpoint.

The author's stated reason for not giving specific consideration to water-works as one of the utilities is that, and rightly, they are for the most part publicly owned. This accords with the consensus of public opinion, but there are in the United States so many privately owned water-works with such a large total capitalization that one might rightly expect a book with so broad a title as "The Economics of Public Utilities" to contain as full a treatment of the special problems of water-works as is given to those of the gas and electric utilities.

Mr. Nash first takes up the origin and development and the "distinguishing characteristics" of public utilities and follows these subjects by a chapter on franchises and another on capitalization. These four chapters together fill only 65 pp. Next there are taken up accounting methods, regulation, valuation, depreciation, rate of return to investors, and rate structures, these six chapters occupying about half the volume.

It is the remainder of the book, unless it be as to method and point of approach, that seems to justify the author in claiming for his volume a "broader" treatment than its predecessors. The subjects treated in the last part of the book are taxation, tests of utility securities as investments, and a related chapter on tests of utility development; public ownership and public relations, a chapter to each; some current utility problems and a final discussion of outstanding issues. It is in this last chapter that the author attempts a brief summary of what he "believes to be the outstanding present problems of the industry," after having remarked that until then he has "refrained from emphasizing his own views" but rather has assembled "the essential facts regarding the development and present status of public utilities and authoritative views on important existing questions." This he has done to a large extent, but as a rule with a strong leaning toward private ownership. For the most part, only one side of the case is presented except where there are differences of opinion among representatives of private ownership or where there is still more or less confusion in court and commission rulings. All this does not particularly harm so long as the reader thoroughly understands that the book as a whole is largely a brief for private ownership. Naturally, the chapter on public ownership contains the most extreme illustration of bias against it, going to the height of absurdity in its reference to municipal ownership of an electric lighting plant at South Norwalk, Conn., where, after paying a compliment to the character of the management, the author cannot resist this fling: "Comparison of South Norwalk with other Connecticut cities, having identical transportation advantages but farther from New York, shows that during the last twenty years South Norwalk has had an almost negligible growth in population and industries, whereas Bridgeport and New Haven have each increased more than 50 per cent in population and have expanded industrially to a still greater extent. It cannot be clearly shown that South Norwalk has stagnated solely or primarily because of lack of aggressive public utility service as an encouragement to industry, but other convincing reasons for this stagnation have not appeared." The uninformed would never for a moment suppose that even after consolidation of South Norwalk with the city of Norwalk and the town of Norwalk the population of the combined municipality in 1920 was only 27,443, whereas as far back as 1900 Bridgeport had a population of about 71,000 and New Haven of 108,000. This is an extreme instance. With allowances for this and less obvious bias, the book is a valuable contribution to utility literature. Most of those who are on the private utility side will welcome it unreservedly.

Engineering and Architectural Drawing

DRAFTING METHODS—By Douglas S. Trowbridge, Sc.M., C.E., Assistant Professor of Civil Engineering, New York University. New York: Codex Book Co., Inc. Cloth; 6 x 8 in.; pp. 155. $2.50.

CONSTRUCTION DRAWING: A Textbook of Architectural Drawing for the Building Trades—By Joseph Brahdy, Licensed Professional Engineer, State of New York, Brooklyn Vocational School, Brooklyn Evening Technical and Trade School; and Samuel Landsman, Registered Architect, State of New York, Brooklyn Vocational School, Bushwick Evening Trade School. New York: D. Van Nostrand Co. Cloth; 11 x 8 in.; pp. 133; 188 drawings. $2.50.

Aside from its value as a drafting guide Professor Trowbridge's book contains two important time-saving chapters—"Kinks" on the use of instruments and one on office detail. Here the draftsman will find numerous suggestions on the easiest use of all his tools, their repair, and the care of material. Most of the "kinks" have been reprinted from technical publications, though some are contributed by the author's professional friends. Whatever their source they undoubtedly will assist many a draftsman to do more expeditious and cleaner work.

"Construction Drawing" concerns itself principally with architectural drawing of the simpler sort. Its technique is confined to practical things and a study of it should make easier work for the building mechanic. Its applicability is best explained by quoting part of the author's preface: "Advanced draftsmanship is not treated and the study of architecture as a fine art has been purposely omitted. It is believed that this method of treatment permits the teacher to impart to a student without previous drafting experience, a cohesive amount of knowledge of a commercial value, i.e., sufficient basic information to enable him to obtain and hold a remunerative position."

PUBLICATIONS RECEIVED

MINE TIMBER, Its Selection, Storage, Treatment and Use, is dealt with in Bull. 235 (115 pp.), Bureau of Mines, by R. R. Hornor and Harry E. Tufft, mining engineers. A chapter on Methods of Prolonging Life of Mine Timber is contributed by George M. Hunt, in charge, Section of Wood Preservation, Forest Product Laboratory, Forest Service. Halftones and line cuts are used. (30c. from Superintendent of Documents, Washington, D. C.)

FINANCIAL STATISTICS OF CITIES of over 30,000 population for the year 1923, one of a long series of compilations by the Bureau of the Census, fills 571 pp., of which 12 are taken up with an introductory summary and 43 with descriptions of the way the tables are made up and summaries of some of the material given in the individual tables ($1 each for copies bound in buckram, from the Superintendent of Documents, Washington, D. C.).

THE BUILDING CODE COMMITTEE of the Bureau of Standards has issued a 29-p. pamphlet entitled Recommended Practice for Arrangement of Building Codes (10c. from Superintendent of Documents, Washington, D. C.).

PLANNING PROBLEMS of Town, City and Region is the title given to the large volume of *Proceedings* of the International City and Regional Planning Conference held in New York City in April, 1925 ($3 from Flavell Shurtleff, secretary National City Planning Conference, 130 E. 22nd St., New York City).

THE FIRE PREVENTION YEAR BOOK for 1925 includes an article on how to organize for fire prevention work and a table giving the annual fire losses in the United States for the 50 years 1875-1924, the figures for the two extreme years being in round numbers $78,000,000 and $549,000,000. (Single copy 50c.; bulk orders of 50 or more, copies 35c. a copy, from Baltimore Underwriter & National Agent, American Building, Baltimore, Md.).

A PROGRESS REPORT on the Stevenson test dam near Fresno, Calif., has been made as Bulletin 2 of the Arch Dam Investigation being conducted under the auspices of Engineering Foundation (29 W. 39th St., New York City). The bulletin contains a halftone plate and a plan and sections showing the dam and a few paragraphs of descriptive text; also a list of those who have contributed from $500 to $25,000 towards the expense of the investigation and the names and addresses of the members of the committee.

PROCEEDINGS of the Fourth Ohio Conference on Water Purification (1924) fill 97 closely printed pages of a report with the imprint of the Ohio Department of Health, Columbus, Ohio.

FIFTEEN CENTS sent to the Engineering Experiment Station of the University of Wisconsin will procure the 59-p. bulletin on Comparative Tests of Buttonhead and Countersunk Riveted Joints, by J. B. Kommers, associate professor of mechanics.

THE DURBAN WATER SUPPLY, by Walter M. Campbell, is an interesting description of the project named reprinted from the *Transactions* of the South African Society of Civil Engineers. For copies address Mr. Campbell, Water Engineer's Office, Durban, South Africa.

THE COMMON BRITISH PRACTICE of putting a price on municipal and other public reports has the advantage that no one interested sufficiently to send the reasonable price fixed need feel hesitancy in applying for any of the documents in which he is interested. For 3½ shillings sent to the Rivers Department, Town Hall, Manchester, England, there may be obtained the report of the Rivers Committee for 1924-25, outlining the operations of the various sewage-works in the committee's charge and giving statistical operating summaries. During the year named a total of nearly 800 U.S.m.g. of sewage was treated by the activated-sludge units installed in 1917 and 1923.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers, at the address given, or from their local booksellers.]

AERONAUTICAL METEOROLOGY—By Willis Ray Gregg, A. B., Meteorologist, U. S. Weather Bureau, Fellow, American Meteorological Society, Fellow, Royal Meteorological Society. [Ronald Aeronautical Library, C. DeF. Chandler, Editor.] New York: The Ronald Press Co. Cloth; 6x9 in.; pp. 144; 33 maps, charts and halftones. $2.50.

Designed to give in concise form "the essential facts of the upper air and to point out their relation to the development and safety of aeronautics." Takes up circulation of the atmosphere, instruments, etc., vertical structure of the atmosphere, winds, fogs and clouds, visibility, thunderstorms, cyclones, etc., weather forecasting, flying over the North Atlantic and North Polar regions, and distribution of weather forecasts by radio. Closes with list of meteorological services of the world, bibliography and conversion tables.

JAHRBUCH DER DEUTSCHEN GESELLSCHAFT FÜR BAUINGENIEURWESEN, 1925. Berlin: G. M. B. H. Cloth; 6x8 in.; pp. 198; 62 line cuts and halftones; section of advertisements.

LEHRBUCH DES TIEFBAUES—Herausgegeben von Esselborn. 6 bis 8 Auflage. Zweiter Band: Brückenbau, Wasserversorgung und Entwässerung der Städte, Kanal- und Flussbau, Landwirtschaftlicher Wasserbau. Bearbeitet von A. Braubach, H. Engels, P. Gerhardt, W. Teubert, Ph. Volker. Leipzig: Wilhelm Engelmann. Paper or cloth; 8 x 11 in.; pp. 894; over 1,300 line cuts and halftones. Cloth, 19, bound, 22.5 marks, gold, in Germany.

STANDARD METHODS FOR THE EXAMINATION OF WATER AND SEWAGE, Sixth Edition—Prepared jointly by Committees of the American Public Health Association and the American Water Works Association, with the collaboration of a Committee of the American Chemical Society on the chemical methods. Sponsored, Approved and Published jointly by the American Public Health Association and American Water Works Association. New York: American Public Health Association. Cloth; 7 x 10 in.; pp. 119. $1.50.

In the fifth edition (1923) the portion on chemical methods was completely rewritten. Since then the bacterial and microscopic section have been revised so it is now believed, says the Preface, that the present edition "represents the best current American practice in the laboratory examination of water and sewage." The co-operative feature of the enterprise, noted in above heading, is commendable.

STATIK DER BODENKONSTRUKTION DER SCHIFFE—Von Dr.-Ing. Walter Schilling. Berlin: Julius Springer. Paper or cloth; 6 x 9 in.; pp. 185; 64 line cuts. Paper, 15 marks, cloth, 16.5 marks, gold, in Germany.

DIE STATIK DES EBENEN TRAGWERKES — Von Martin Grüning, ord. Professor and der Technischen Hochschule zu Hanover. Berlin: Julius Springer. Cloth; 6 x 9 in.; pp. 706; 434 line cuts. Cloth, 45 marks, gold, in Germany.

STATIK FÜR DEN EISEN- UND MASCHINEBAU—Von Dr.-Ing. Georg Unold, Professor an der Staatlichen Gewerbe-Akademie in Chemnitz. Berlin: Julius Springer. Cloth; 7 x 10 in.; pp. 342; 606 line cuts; 38 tables. Cloth, 22.5 marks, gold, in Germany.

TURBINES HYDRAULIQUES—Par A. Rateau, M. L'Académie des Sciences; D. Eydoux, Professeur a L'École Nationale des Ponts et Chaussées; et M. Gabriel, Directeur Géneral des Atéliers Néyret-Beylier et Piccard-Pictet. Avec le patronage de la Société des Ingénieurs civils de France, de la Société d'Encouragement pour l'Industrie National et de la Société Hydrotechnique de France. [Encyclopédie de Mécanique Appliquée, Publié sous la direction de M. L. Lecornu, Professeur a l'École Polytechnique et a l'École Nationale Supérieure des Mines, Membre de l'Institut.] Paris: Librairie J.-B. Balliere et Fils. Paper; 6 x 9 in.; pp. 692; 178 line cuts; bibliography, index. 70 francs.

A detailed treatise on the theory of hydraulic turbines and related matters.

"VERBAL" NOTES AND SKETCHES ON MARINE DIESEL OIL ENGINES: A Manual of Marine Oil Engine Practice—By J. W. M. Sothern, M. Inst. of Engineers and Shipbuilders in Scotland, and other societies, Principal of Sothern's College of Marine Engineering, Glasgow, Author of "Verbal Notes and Sketches for Marine Engineer Officers," "The Marine Steam Turbine," "Marine Engine Indicator Diagrams," "Oil Fuel Burning in Marine Practice." Second Edition. London: Crosby Lockwood & Sons. Cloth; 6 x 9 in.; pp. 766; 444 line cuts and halftones. 42s. net in London, postage 1s.

A second edition of a comprehensive work, which, although designed primarily for those about to take certain examinations in England, is also intended for the use of "engineer superintendents and shipbuilders," presumably including engineers and contractors engaged in dredging operations.

WASSERKRAFT-JAHRBUCH: 1924—Herausgeber, Oberbaudirektor K. Dantscher, Ord. Professor, München; und Ingenieur Carl Reindl, München. München: Richard Pflaum. Boards; 6 x 9 in.; pp. 612; 279 halftones, line cuts and charts, and 13 tables. Bound, 24 marks, gold, in Germany.

With commendable enterprise this year book on water power engineering and construction, the first of a projected series, has been undertaken. Reviews for many of the countries of Europe, including England and Greece, are contributed by engineers representing each of the countries, after which there are technical articles on canals, pipe lines, pumps, turbines, etc.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Duralumin and the "Shenandoah"

Sir—In your editorial in the issue of Nov. 26, on duralumin and the "Shenandoah," you take account of sentiment and psychology, which usually are not considered to have important bearing in engineering investigations. In this instance, the paramount feature is not one of engineering in general or even a specific one of strength of materials, but is one of mob psychology; and it is very interesting to speculate upon the possible causes which have led a journal of the high character of *Engineering News-Record* in this instance to follow the crowd in its course of thoughtless condemnation.

Although not interested in the aircraft controversy in any way other than as an engineer, I submit herewith my thoughts relative to the various points raised in your editorial; for I must confess that the impression which your article left upon me is painful and cries for relief. I submit first a minor but important correction, which is that the embattled opinion was not over whether an officer and a gentleman should or should not prepare canned testimony, but whether he did prepare or attempt to prepare such testimony. Developments have now shown that the Judge Advocate proceeded strictly within the bounds of his duty and of his authority.

In regard to duralumin, the scope of the naval inquiry is limited, both by the court's instructions and by every dictate of good business, to the immediate concern, which is whether or not the condition of the metal had changed in such a way as to lower the strength of the ship. The answer to this question was favorable and, according to *Engineering News-Record*, not open to doubt. And yet you proceed, with an "if we are not mistaken," to express doubts as to the toughness of the duralumin of which the vessel was built. The Court of Inquiry is not examining into the use of duralumin for general purposes, and is not in any way concerned with deterioration which might have gone on and might in time have made the vessel worthless. The implication, therefore, contained in your statement that "these facts, of possible bearing on the condition and fate of the 'Shenandoah,' appear to have been withheld from public knowledge by the Court of Inquiry," is unjust to the court, and the statement that "we do not profess to guess why this was done" can be taken only as a thoughtless remark.

In regard to your four conclusions, there are some points worthy of remark, as follows: "The designers and builders of the ship knew that it was too weak to resist the severest weather conditions"; just as the designers and builders of any seagoing ship know that it is not built strong enough to withstand being wrecked if thrown up on a leeshore. The statement that "the directing officials and personnel of the Navy, though they had this knowledge at their command, utterly disregarded it in dealing with the 'Shenandoah' as though it were an all-weather ship" seems to have been written without taking into account the postponements of the "Shenandoah" flights which were made in order to avoid the season of probable storms.

Your next point (3) is "alterations never contemplated by the designers." The inference to be gained from this remark is that the design was perfect and that, therefore, no alteration should have been made. The history of aircraft development points in exactly the opposite direction, and it is a fact that substantially all progress in the design of aircraft has been made by trial and error, by the improvement of existing machines. Is *Engineering News-Record* not aware that water-recovery is essential to long-distance flights of dirigibles, and that water-recovery apparatus was not perfected until after the completion of the 'Shenandoah"? And that means for conserving helium, of which the "Shenandoah" then held practically all the world's supply, must be considered as a radically different problem from the means of conserving so common a gas as hydrogen. This criticism might well have been withheld until authoritative evidence came forward to show that these alterations were in any way a contributing cause to the loss of the ship.

E. R. GAYLER,
Commander, (CEC), U.S.N.

Washington, D. C.,
Dec. 8, 1925.

Progress in Soil Mechanics

Sir—The series of papers by Dr. Charles Terzaghi on the mechanics of soils has been followed from week to week with a great deal of interest. More proof has been furnished in recent times of atomic structure than of the very existence of man; but how little is known, on the other hand, of this actual, visible, tangible matter whose laws and properties Dr. Terzaghi essays to discover—that gross palpable matter which the engineer must employ in his levees and dams and in which he must found his structures! The editor has already cited the fact that most of the engineer's calculations in connection with the theory and application of the laws of earth resistance have originated from hypotheses evolved in the inner consciousnesses of Rankine and Coulomb. Notwithstanding the interest that attaches to their "algebras," it is doubtless a welcome fact to the profession—the road and tunnel builders and river and harbor engineers—that on the basis of precise laboratory methods the laws of earths or soils may in future be determined "behavioristically," to use the modern psychological term. The writer recalls in this connection the words of a distinguished hydraulic engineer, the late Joseph Frizell, that "experiments cannot be intelligently conducted until their nature and scope have been indicated by the result of mathematical inquiry; neither can their results be intelligently co-ordinated and understood without recourse to the same potent instrument of investigation." Therefore this modern type of research should be acceptable to the engineering profession. It indicates an advance along progressive lines.

The investigation parallels in certain respects that formerly conducted by the writer for the Foundation Soils committee of the American Society of Civil Engineers at the Bureau of Standards, also those being continuously carried out by the U. S. Bureau of Roads, the U. S. Bureau of Soils, and a number of the engineering experiment stations. The importance of obtaining the law of dampening of hysteresis loops as a criterion for soil comparisons was first suggested by the writer in a progress report of the soils committee. (*Proceedings*, Am. Soc. C. E., Aug. 1920, p. 937.) This type of method has already been employed with decided advantage in grading felts, wools, and various other textiles. Recent tests made at Iowa State College show the decided utility of the method in connection with soils problems.

Strictly speaking a soil is a visco-elastic matter. This is the point of view of the seismologist. It has of course some degree of elasticity, as one may note from the vibrations in driving a stake. It will be necessary, however, to abandon the notion that the elastic modulus has any degree of constancy as in the case of metals. The writer has found it convenient to follow methods similar to those of thermodynamics and take moduluses (derivatives of stress with respect to strain) at constant volumes and constant pressures, etc. One must again consider the time element as is done in the theory of viscosity. Even in the case of the purely static theory of columns Dr. O. H. Basquin has found a variable or tangent modulus most useful. The conception is absolutely imperative in the case of visco-elastic media.

Dr. Terzaghi obtains values of K, the Poisson ratio, as high as 0.75. This is apparently an anomaly. It indicates his clays expand under compression. Such a phenomenon must be very disconcerting to an elastician who limits the range of this modulus to zero to 0.5, as exemplified for the case of cork at one extreme and dense India rubber at the other. A rational explanation of this paradox will be a matter of interest to engineers who are investigating the laws of foundations.

It has been stated by Dr. Terzaghi that the Iowa State College test pieces were not homogeneous. But as once stated (1856) by John Tyndall—"There is no such thing in nature as a body of perfectly homogeneous structure." So

it would seem best to take the points of view of Prof. Gaetano Lanza, J. E. Howard, Ralph Chambers and many prominent engineers and employ matter "as is." Indeed it has been urged by one authority that the ordinary conceptual continuous homogeneous matter of textbooks, since it has neither where nor whither in which to compress by its lack of voids, should be quite as incompressible as the late Osborne Reynolds' aether, which bore 750,000 tons to the square inch. This question of intrinsic structure was deemed so important by the Mine Cave Commission of Pennsylvania in its efforts to mitigate subsidence at Scranton that, among other things, they boxed and transported intact at considerable expense a 5-ft. cube of bituminous coal to be tested in the 10,000,000-lb. testing machine of the Bureau of Standards, rather than employ uncertain hypotheses.

Hypotheses as to homogeneity and continuity may easily lead to very incorrect conclusions. To cite one case in the dynamics of viscosity, investigators have assumed that a perfectly homogeneous fine-grained soil will transmit liquids through its pores in accordance with the first-approximation law of Poiseuille, $Q = \pi R^4 (p_1 - p_2) / 16u$. As a matter of fact the late Prof. F. H. King (in "Movement of Ground Waters," U. S. G. S., 1899), F. H. Newell, D. Welitschkowsky and many other investigators have produced evidence to show this law is only an approximation for fine-grained soils and even for fine-grained sandstones. It holds fairly well for natural loams, but not at all for natural undisturbed clays, because of the dscontinuous structure. One should accordingly find these properties by tests and not select facts so as to harmonize with *a priori* mathematical laws. Again, the discussion on "capillary pressure" introduces an important class of physical phenomena which have been little investigated by engineers and should be carefully considered.

It has been stated "it is to be regretted that the Iowa investigations could not be supplemented by contemporaneous loading tests performed with the soil testing apparatus proposed by the Foundation Committee." Systematic tests to determine the laws of subsidence of foundations as a function of loading, areas, times, and other variables have been in progress at this institution for some time in accordance with a much larger program of Director Marston. The tests cover soils both disturbed and undisturbed, on a scale of magnitudes commensurate with practice as well as on laboratory scale.

While the laboratory tests and field explorations are furnishing more valuable data for the profession the problem must ultimately be solved by the engineer himself. Prof. Lanza's pioneer work on field tests was carefully considered in carrying out the Iowa State College program. His apparatus indeed is a prototype of that employed by the College and by the Soils committee. Recognition should be given to important field tests made from time to time. For example, the Annapolis tests on long piles by P. J. Carlin, (*Engineering Record*, May 11, 1901; *Transactions*, Am. Soc. C. E., Vol. 48, pp. 215-218), and quite recently those by Ralph Chambers (*Engineering News-Record*, Oct. 12, 1922, and Jan. 15, 1925) for the Nebraska Capitol furnish data greatly needed by the profession, direct in their application and of a kind that cannot be controverted. A large mass of this class of data has already accumulated. It would seem desirable that it be collated and codified in accordance with the original program of the Foundation Soils committee of the American Society of Civil Engineers for the definite determination of laws.

J. H. GRIFFITH,
Professor of Experimental Engineering, Iowa State College.

Ames, Iowa,
Dec. 4, 1925.

Sir—Mr. Griffith apparently mistakes the value of *K*, the ratio between horizontal and vertical pressure, given as 0.75 in a particular instance (p. 748, Nov. 12 issue), for the value of Poisson's ratio printed alongside and given as 2.55, a figure which corresponds to a lateral expansion of 1/2.55 or 0.392. This mistake and several other comments which indicate a misunderstanding of statements in the original articles suggest that he may have read the writer's articles somewhat hastily.

If Mr. Griffith believes that any of the facts stated in my articles were selected to fit *a priori* conclusions as to mathematical laws, I may take the liberty of stating definitely that all the laws which I presented were deduced from test results. Apart from anything else, my analytical powers are not great enough to enable me to conceive such laws in advance. The laws as deduced are the result of conscientiously applying Mr. Frizell's principle as cited by Mr. Griffith. However, I am not able to co-ordinate this citation from Mr. Frizell, given in the first part of the preceding letter, with the remedies proposed at its end.

The results of large-scale tests, such as Mr. Griffith mentions, surely cannot be controverted. Without a science of soil physics, however, they cannot be interpreted. Their value essentially depends on the degree of our physical insight.

CHARLES TERZAGHI,
Massachusetts Institute of Technology.

Cambridge, Mass.,
Dec. 9, 1925.

Speed of Moving Sliding Forms

Sir—On the Canadian government elevator at Prince Rupert, B. C., we jacked moving forms of the workhouse 14 ft. 1 in. in 24 hours, running two shifts of 9½ hours each. We believe this to be a record. The workhouse consists of 24 circular bins 13 ft. in inside diameter with outer and inner space bins and leg belts.

D. M. SHEARER,
Carter-Halls-Aldinger Co.

Prince Rupert, B. C.,
Sept. 14, 1925.

This inquiry was referred to R. F. Egelhoff, author of the comprehensive article on sliding forms, *Engineering News-Record*, Nov. 12, 1925, p. 786, whose comment follows.

Sir—The speed of 14 ft. 1 in. made by the Carter-Halls-Aldinger Co. on the Canadian government elevator at Prince Rupert, B. C., is unusual. Ordinarily, a speed of from 10 to 12 ft. on sliding form work is considered very good. The speed which can be made with sliding forms is entirely dependent on a number of factors, chief among which are: (1) The time of setting of the cement; (2) weather conditions and temperatures; (3) the dimensional layout of the building; (4) design of vertical reinforcing, and (5) thickness of wall.

On the speed of 14 ft. 1 in. made on the Canadian government elevator at Prince Rupert, using two shifts of 9½ hours each, it is evident that with sliding forms 4 ft. in height, the fresh concrete exposed below the forms at some time during the day was but 5 hours and 24 minutes old. With extremely warm weather, this concrete should have reached its final set in that time. Under laboratory conditions, however, the final set of ordinary cement varies anywhere from 4½ hours to 8 hours. I have checked up our records on a job which we built during the past summer where a total of 34 carloads of cement was used. The testing laboratory's reports on these 34 cars show that the average time for final set for the cement was 6 hours and 35 minutes, the lowest final set for any one car being 4 hours and 33 minutes and the highest period for final set on any one car being 8 hours and 10 minutes. It is evident that were this cement to be used in sliding form work at a temperature not in excess of 70 deg. a speed of 14 ft. 1 in. in 24 hours using two 9½ hour shifts would not be safe.

The weather conditions are a great factor in the speed which can be made with sliding forms, as the concrete exposed below the forms should have its final set before being exposed, and, incidentally, called upon to carry a load.

Where the structure being built with sliding forms is of large diameter necessitating a working platform of long span, a great deal of strain is placed upon the sliding forms and upon the wall just freshly exposed below the forms due to the vibration and bending in the working platform caused by buggies of concrete and steel being transported over it. On small diameter bins where the strain placed upon the forms and the freshly poured concrete walls is very much less, a greater speed can be obtained with the sliding forms without impairing the safety of the structure and the workmen.

In structures where there is considerable vertical reinforcing steel, the vertical steel may be depended upon to carry some of the load and to absorb some of the shock to which the freshly poured walls are subjected.

The thickness of wall is a large factor in determining the speed which can be made on a structure with sliding forms, as a wall 12 in. in thickness, even when just freshly poured, will carry a great deal more load than will a wall 6 in. in thickness.

R. F. EGELHOFF,
Turner Construction Co.

New York, N. Y.
Dec. 2, 1925.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Sanitation in Lake Region Discussed by Engineers

Pollution of Lake Michigan Water Considered—Co-operation Between Cities Needed

A dozen leading sanitary engineers of the country addressed the second annual meeting of the Lake Michigan Sanitation Congress held in St. Joseph, Mich., Dec. 11 and 12. C. M. Baker, sanitary engineer of Wisconsin and T. Chalkley Hatton, chief engineer, Milwaukee Sewerage Commission, prophesied a continuous city from Milwaukee to Chicago, whose sewage and water supply required concerted and co-operative action to handle. At present only one city, South Milwaukee, in Wisconsin south of Milwaukee, treats its sewage. Both Michigan and Wisconsin health boards are co-operating with conservation commissions.

"Clean Up Lake Michigan"

George W. Fuller, consulting engineer, New York, outlined a definite practical program by which the slogan of the Congress "Let's clean up Lake Michigan" might be accomplished. Among the effective remedial measures noted are these: Comprehensive plans for interception and delivery to disposal sites; rigid adherence to such plans by all new works; selection of a suitable preliminary treatment plus sterilization or full treatment if and when required; where they affect water supplies elimination of trade wastes or treatment at the source; establishment of an adequate administrative authority and a reasonable program of financing together with education of the public to support the program; installation of water filters; adoption of a program for financing proper operation of filters and disposal works when built. Harrison P. Eddy's paper on "Importance of Maintaining the Purity of Lake Michigan Waters," read by A. L. Fales, concluded that the majority of water supplies from the lake should be filtered even under the most favorable conditions because of surface wash, storm overflows, navigation and recreation use of the lake.

Pollution at Chicago

The pollution of the water supply of Chicago by the back flow into the lake from both the Chicago and Calumet Rivers was stressed by Charles B. Burdick, consulting engineer, Chicago. Filtration is essential now, in his opinion, particularly for the southern cribs since the Calumet overflows into the lake twenty-two times per year. Dr. I. D. Rawlings, Illinois State Health Commissioner, also said that filters are essential for Chicago's southern cribs. He cited the recent experience where four times during a month the excess chlorine used as a factor of safety had entirely disappeared even though the dose had been increased to 6 lb. per million gallons.

Hammond, Whiting and East Chicago are getting a joint plan of sewage disposal. Ray Seeley, Hammond, indicated the alternatives only, conclusions not yet having been drawn. The same kind of a report was made by H. R. Crohurst, U. S. Public Health Service, who has been making a co-operative bacterial study of 80 sq. miles of Lake Michigan from 68th St. to Gary with the Chicago Board of Health, Sanitary District of Chicago, Illinois and Indiana State Boards of Health. About 5,000 analyses have been made and results of two seasons work are now being assembled.

All of the former officers were re-elected. Henry W. Lee is president and J. A. Henricks, Hammond, secretary.

Engineering Fifty Years Ago

From *Engineering News*, December, 1875

Railway Equipment

THE Chicago and Northwestern railway car shops in the suburbs of Chicago are now so nearly completed that they will be in running order within thirty days. A new boiler shop for the locomotive department has just been finished. This department will employ 400 men. The old car shops in Chicago will be abandoned. The company is now building two baggage cars 40 feet long, with 4-wheel trucks, and one 50 feet long, with 6-wheel trucks; also a 46-foot passenger coach.

Sixteen new drawing-room and sleeping coaches are being built by the Wagner Car Company for the Michigan Central railroad. Six hotel cars are also in process of construction, three of them being nearly completed.

Overloaded Roof Collapses at Wilmington, Del.

The roof of the stage section of the Playhouse Theater at Wilmington, Del., collapsed during the evening of Dec. 11 while a performance was in progress in the house. It is reported that the collapse was due to an accumulation of water upon the roof, resulting from a stoppage of the drain pipes. None of the performers who were on the stage at the time of the collapse were seriously injured.

Plans Made to Supply Water to Suburban Chicago

Two Water Companies Ask to Serve Cities in Sanitary District with Lake Water

The Greater Chicago Lakes Water Co. and the Municipal Water Co. have both made application to the Illinois Commerce Commission for a "permit of necessity and convenience." The first would build to supply 700,000 people in the 100 towns within a 28-mile radius of a point near 22d St. and Harlem Ave., and the second to care for 23 municipalities having 270,000 people closely bordering on the Chicago city limits. Hearings were held Dec. 8 and 9, and will be continued Dec. 22. Details of the plan of the Municipal Water Co. (see *Engineering News-Record* July 9, p. 76) were presented by Charles B. Burdick, of Alvord, Burdick & Howson, indicating a need for the water in all of the "cities which do not border on Lake Michigan and now obtain an inadequate, unfiltered supply either from Chicago or hard water from wells that are rapidly being depleted."

Chicago is obligated by the Act creating the Sanitary District of Chicago to furnish water to any town within the Sanitary District limits, but during the summer months it cannot supply its own people adequately and John Ericson, city engineer, testified that he could not hold out any hope that these outside cities would be better served for 10 or 15 years. He based his opinion on the slowness of metering in the past, and the lack of bonding power for money for filters. The 10-year metering program, forced through the City Council last fall, will have to be well along, he said, before filters can be built, but provision in the budget for the first installment had so far been eliminated. The towns had better look to one of the water companies for relief, he finally stated.

Two Propositions

The Greater Chicago Lakes Co., which is backed by Thomas Doolan, and two large contracting companies, the T. J. Forschner Contracting Co. and Nash Brothers, so S. M. Savage, their consulting engineer, testified, proposed a $32,000,000 plant to furnish unfiltered Lake Michigan water and let each town filter it if they desired to do so. He proposed a 14-ft. tunnel narrowing to 10 ft., four miles into the lake off 22d St. and seven miles inland under the city of Chicago to a pumping station just west of the city limits, from which force mains would radiate to the various towns. The system would cover such cities on the outer limit as Chicago Heights, Joliet, Aurora, and Elgin. The cities on the lake shore north of Chicago were not included. The Municipal Water Co. plan contemplates a 3,000-ft.

tunnel from a crib off shore from Wilmette to a 75 m.g.d. pumping station and 50 m.g.d. filter plant from which distribution could be made to the cities immediately contiguous to the Chicago west limits as far south as Riverside. Other cities would be added as the business could be obtained.

Large Rail and Water Terminal to Be Built at Toronto

Arrangements are practically complete, according to an announcement made at Toronto, Ontario, for the erection of a water and rail terminal warehouse there costing in the neighborhood of $8,000,000, and covering between twelve and fifteen acres on the harbor front, to handle American and European products.

The new structure, according to plans under preparation, will be eight stories in height, of reinforced concrete and fireproof, and will cover an area of almost eight acres, affording one million square feet of floor space.

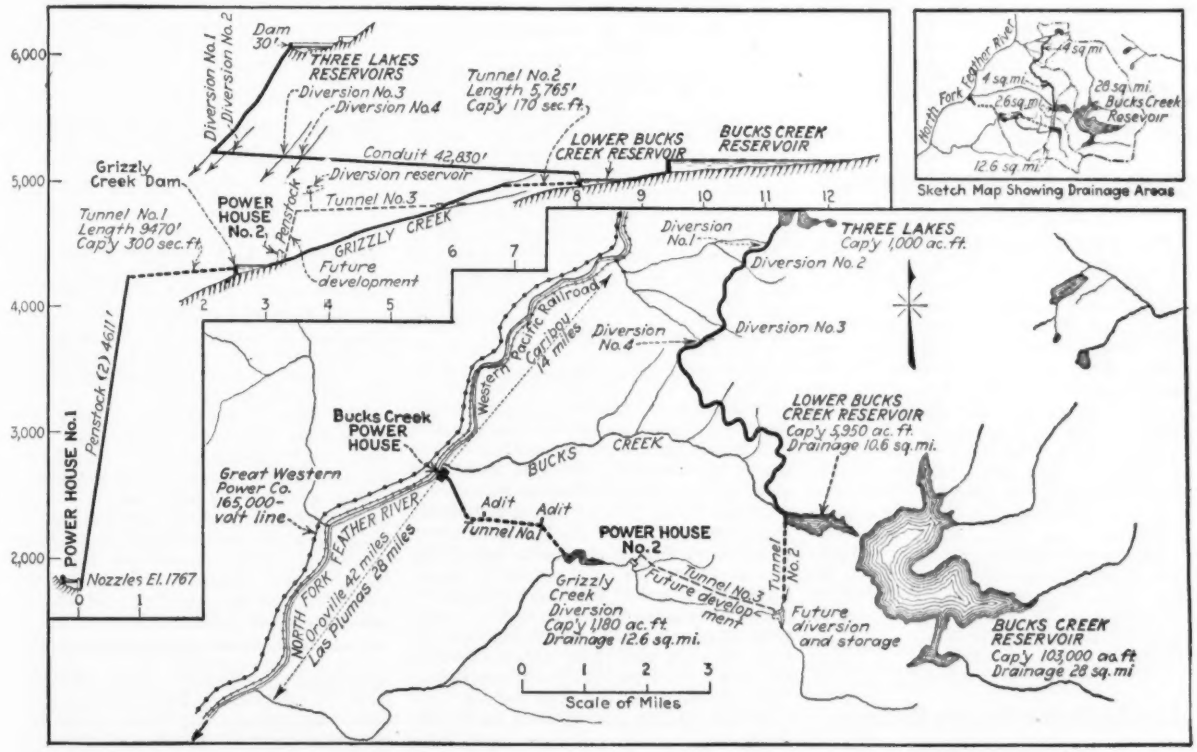
Program of the Road Builders' Association Meeting

The program of the meeting of the American Road Builders' Association to be held in Chicago, Jan. 11-15, has a dsitinct feature in that separate meetings will be held to discuss engineering problems and constructors' problems. The technical sessions will begin on Tuesday afternoon with the engineers discussing financing and locating highways, and the constructors discussing making the contracting business pay. This will be followed by a general session Wednesday morning on the subject of traffic, a joint meeting with the National Highway Traffic Association, at which safety, future developments of the motor vehicle, and the possibility of motor vehicle transportation as a supplement to railroad operation will be discussed. Wednesday afternoon the engineering problem section will discuss construction and the constructors' problem section will discuss practical operating methods. On Thursday the two sections will discuss operation and maintenance and enlarging the contractors' field, respectively. Thursday afternoon, at a general session, the subject will be the contractor and the engineer.

Large Canal Lining Project Starts in the West

The placing of 800,000 sq.yd. of concrete lining in the irrigation canal of the Salt River Valley Water Users Association in Arizona was begun recently. The work is being undertaken to reduce the seepage from the present canals and thus save enough water to irrigate 42,000 acres of land in the Roosevelt water conservation district. The latter district has lands adjacent to those of the Salt River Valley Water Users Association. Water will be pumped from the canals of the latter district to those of the Roosevelt district through a lift of about 50 ft.

Electrically welded steel mesh is to be used for the reinforcing of the lining which will be placed with cement guns. The estimated cost of the work is $750,000.



PLAN AND PROFILE OF FEATHER RIVER POWER CO. DEVELOPMENT NOW UNDER WAY

Work Starts on Power Project to Use Head of 2,552 Ft.

The Feather River Power Co. of San Francisco has awarded a contract to R. C. Storrie & Co. for the construction of the Bucks Creek hydro-electric project on the north fork of the Feather River and has disposed of its holdings on the middle fork, including the Bean Creek and Nelson Point-Sherman Bar sites, to the H. M. Byllesby Co.

The work on the Bucks Creek project this winter will consist in road and camp construction and other work preliminary to the beginning of operations on a large scale next spring. This plant which is to contain two 30,000-hp. units is to be completed, under terms of the contract, by Dec. 31, 1927. The contract price was $7,691,889.

Since a previous announcement about the plans for this work appeared in *Engineering News-Record*, May 21, p. 867, designs have been changed so that the static head on the plant has been increased to 2,552 ft. Four dams are included in that part of the project planned for immediate construction, the relative locations and reservoir capacities being given in the accompanying map. Power development No. 2 to be located between the upper dams and plant No. 1 is not included in the present contract and is planned for development at some later date.

Large Water Main Breaks in Philadelphia

Between four and five million gallons of water from the East Park reservoir in Philadelphia were lost, and damage done to properties in the path of the flooding water, when a 48-in. main broke suddenly on Dec. 12, about 5:00 a.m. The main carries water from the reservoir to West Philadelphia. At the point where the break occurred the pipe passes through Fairmount Park and has a fill of about 18 ft. of earth above it. The force of the flood from the 25 ft. head of water in the reservoir, washed through this fill and caused damage to properties on the side of the street opposite to the park, and to the tracks of the Pennsylvania R.R., where the fill on which the tracks are located was washed out and a considerable amount of earth deposited on the roadbed of the Philadelphia and Reading Ry. The pipe was a cast iron line, laid about 1890.

It is of interest to note that the entire time the water supply was interrupted, from the time of the break until connections with other sources were effected, was shown clearly on recording apparatus which has been set up in connection with a survey of underground leakage which is being made for the Water Bureau of Philadelphia by the Pitometer Co.

$2,000,000 for Waterways Work and Equipment

The Inland Waterways Corporation, at a meeting held in St. Louis on Nov. 25, approved an expenditure of $1,500,000 for new equipment for the Mississippi and Warrior River barge line service and for co-operation in building joint rail and river terminals at Helena, Ark., and Baton Rouge, La. It is proposed to loan $110,000 to these two cities for the terminal work. This program must be ratified by the Secretary of War, but appropriations already made and surplus earnings of the barge line are sufficient for the new equipment.

The corporation has under consideration an offer by a delegation from St. Paul and Minneapolis of $600,000 for equipment if the barge line service is extended to those cities.

Williston Project Sold by United States

On Nov. 20 the Secretary of the Interior sold the Williston reclamation project, Williston, N. D., for $151,388 to the United Power Co. of Crosby, N. D., the high bidder. Other bids ranged from $750 to $80,000. The sale price is to be paid in 20 installments, with 6 per cent interest, and the purchaser will also pay 20c. per ton for coal mined from the government coal mine connected with the power plant. The project, which consists mainly of a power and pumping plant, cost about $470,000, of which none has previously been repaid.

Army Engineer Reports Corps Activities

Increase in Personnel—Would Aid in Preparation of U. S. Maps—Power Survey Made

The Chief of Engineers, U. S. Army, in his annual report to the Secretary of War for the year ended June 30, 1925, reports a small increase in the commissioned personnel of the regular army engineers and an increase of over 700 in the reserve officers. There also was a small increase in the engineer officers in the National Guard. During the year considerable effort has been devoted to the organization of the reserve officers into units and there has been considerable progress, especially in the organization of units of the transportation service.

The Chief of Engineers laid stress upon the need of funds in order that the Corps of Engineers may assist the U. S. Geological Survey and the Coast & Geodetic Survey in the preparation of topographic maps authorized by the Temple Bill. With sufficient funds army engineers can materially aid in this work and at the same time gain practical experience of considerable value in a war-time emergency.

Industrial preparedness has received considerable attention from the Corps during the year. Procurement districts have been established in the larger centers throughout the country, and the organization of staffs to handle the districts has made good progress. A note of warning in the matter of military unpreparedness is sounded by the Chief of Engineers at the close of his report in a statement to the effect that most of our harbor defense fortifications are either obsolete or have become relegated to secondary importance.

Report to Congress

In his annual report to Congress the Chief of Engineers reports on the survey which the Army is making of the power resources in industrial areas. On that subject General Taylor says:

"A survey of the electric power plants and resources of the United States was commenced during the fiscal year 1922. It was desired by this means to obtain information and to develop plans which would enable the nation to utilize to the utmost all available electric power in time of war, and to assure the fairest and most efficient distribution to industries which would be engaged in work essential to the prosecution of hostilities.

"The objects of the survey are to collect data on existing power companies of over 5,000 kilowatts capacity; to establish contact with the principal men in the power-production business; to seek the cooperation of producers in so planning their extensions and new developments as best to meet war-time needs; to ascertain the possibilities of increased power development in combination with navigation improvement, flood control, or otherwise; and to ascertain the best system for the government to adopt for developing power resources and for administering power distribution in a national emergency. The study is not taking the form of costly field investigations, but is being conducted by personal conferences and correspondence with power producers at slight cost beyond occasional trips to large power centers.

"An initial survey of the situation for the entire continental United States has been completed, and a report based thereon was during the year transmitted to, and approved by, the Assistant Secretary of War. The plan contained in this report contemplates the division of the country, for peace-time investigation and war-time administration, into 11 territorial power zones. During peace-time, the necessary work and investigation in each power zone will be under a division or district engineer located therein."

Railroad Consolidation Plan Opposed by Commission

The Interstate Commerce Commission, in the report which it has just made to Congress, states that in February last the commission, in a letter to the chairman of the Senate Committee on Interstate Commerce, reported that the majority of the commission doubted the wisdom of the provisions of the law which now requires the commission to adopt a complete plan to which all future railroad consolidations must conform. The letter stated further that the majority had been impelled to the belief that results as good, and perhaps better, are likely to be accomplished with less loss of time if the process of consolidation is permitted to develop, under the guidance of the commission, in a more normal way. For this purpose, the commission submitted to the Committee on Interstate Commerce a proposed amendment to the Interstate Commerce Act which would accomplish the following results: (1) Relieve the commission from its present duty of adopting a complete plan of consolidation; (2) make unlawful any consolidation or acquisition of the control of one carrier by another in any manner whatsoever, except with the specific approval and authorization of the commission.

Alaska Railroad Deficit Reduced Despite Traffic Loss

The deficit of the Alaska Railroad, owned and operated by the U. S. Government, for the fiscal year 1925 amounted to $1,246,674, or a decrease of $489,900 over the previous year. The total number of tons of commercial freight handled by the railroad in 1925 was 53,865, a loss of 9.7 per cent over the previous year, due to a decrease in ore shipment. Passenger traffic fell off 2.4 per cent.

The loss in operating income, was more than offset by economies in reduced maintenance cost and a small reduction in the number of employees.

The general manager in his report emphasized the need of completing the railroad at an estimated cost of $11,878,000, in order to reduce the high maintenance costs, especially in the matter of wooden bridges, which are now in need of replacement.

Rivers and Harbors Congress Asks President's Aid

Washington Correspondence

Completion within five years of all authorized river and harbor projects was urged upon the President, the Vice-president, the Speaker of the House of Representatives, and the Chairman of the Appropriations Committee of 40 members of the National Rivers & Harbors Congress which was in session in Washington last week. The President spoke so favorably of waterways development that Representative Riley J. Wilson, the president of the Rivers & Harbors Congress, on leaving the White House said that "Inland waterways never before have had such a friend in the White House as is Calvin Coolidge."

Some $200,000,000 worth of river and harbor improvements have been authorized, but appropriations have lagged behind. The budget carries $40,000,000 for river and harbor projects, but the President has indicated that he will approve a deficiency appropriation if it becomes evident that more money can be spent to advantage during the next fiscal year.

In a formal resolution the Rivers & Harbors Congress went on record favoring general surveys, under the direction of the Chief of Engineers, U. S. Army, of all navigable streams "not only for navigation improvements but for power developments, flood prevention, and reclamation by irrigation and drainage."

Partial Building Collapse Kills Two Workmen at New York

The collapse of the rear portion of a house at 26 West 47th St., New York, on Dec. 12, resulted in the death of two workmen and injury to six others. At the time of the accident the building, a four-story and basement brick dwelling of the typical city block type, was being remodeled. A new front had been built on and the rear wall was being altered. The front portion of the house occupies the whole width of the lot, but the rear portion is slightly narrower, leaving a small air court between the north wall and the adjoining building to the north, a new office building. It was the rear portion of the house that collapsed, the north side and rear walls and all the floors and roof falling into the basement, leaving the south wall standing.

Appearances seem to indicate that the north wall buckled inward. The floors and roof fell almost vertically and very little, if anything, fell against the side wall of the building to the north. There was nothing left to indicate how much of the rear wall had been cut away before the collapse. The workmen carried down in the collapse were working on the rear wall. Reports from a preliminary secret investigation by the superintendent of buildings are to the effect that inspectors had visited the building five days before the collapse and had found the floors properly shored and no undue accumulation of bricks on the floors at that time.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention, Chicago, Ill., Jan. 11-15, 1926.

AMERICAN ENGINEERING COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 14-15, 1926.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; Annual Meeting, Portland, Ore., Jan. 19-23, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 20-22, 1926.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Toronto, Ont., Jan. 27-29, 1926.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 23-26, 1926.

Personal Notes

HERBERT NUNN, city manager of Santa Barbara, Calif., who did effective work at the time of the Santa Barbara earthquake in protecting the city's utilities and in making immediate arrangements for reconstruction, has resigned. He will probably remain in office until Jan. 1. Mr. Nunn was appointed city manager early in 1924, coming from the position of manager of the Contractors' Association of Northern California. He was city engineer of El Paso, Texas, from 1911 to 1913 and then spent eight years in highway engineering in Oregon, first as chief engineer of Multnomah County and later as state highway engineer.

HAL MOSELEY, who was recently appointed a member of the Texas State Highway Commission, is a graduate of the Texas Agricultural and Mechanical College, was at one time a member of the Dallas, Texas, city commission and for some time, beginning in 1913, was city engineer of Dallas.

E. R. POLLEY has been appointed general manager for Fairchild Aerial Surveys, Inc., of New York, vice E. E. Beveridge, resigned. Mr. Polley is a graduate of Renssalaer Polytechnic Institute and gained his early experience on the engineering staff of the Standard Oil Co. of New York, followed by field experience in South America, and for some years past has been manager of the Canadian branch house known as Fairchild Aerial Surveys Co., Ltd., at Grand' Mere, Quebec, where he had charge of extensive aerial mapping undertakings.

JAMES L. DAVIS, who since 1914 has been employed by the Vermont State Highway Department, with recent work as resident engineer on federal-aid projects in the state and then as assistant engineer of bridges for the department, has resigned and taken a position as resident engineer on municipal improvements at Eau Gallie, Florida, for the city engineer there; his address will be Melbourne, Florida.

GEORGE A. REED has recently been appointed commissioner of public works for the city of Montpelier, Vermont, resigning his position as assistant chief engineer of the Vermont State Highway Department to take up this new work.

JAMES J. MAHAR has been appointed to a newly created municipal engineering position in Boston, which has the title of domestic engineer; he will have charge of the fuel and light for the public schools of Boston for the purpose of reducing the requirements in these commodities for use in the schools. Mr. Mahar is a graduate of Massachusetts Institute of Technology. In 1902 he entered the schoolhouse department of the city of Boston and in 1918 was appointed a schoolhouse commissioner.

H. A. MOORE CO., INC., contractor and builder, has moved its offices from Milton, Pa., to the Y. M. C. A. Building in Sunbury, Pa.

DUDLEY F. HOLTMAN, of Chicago, has been appointed assistant director of the National Committee on Wood Utilization. About five years ago, Mr. Holtman was called to the post of construction engineer of the National Lumber Manufacturers Association for the compilation of data concerning lumber for the use of engineers. His service with the Committee on Wood Utilization will continue along these lines.

JOHN MCGREGOR, county highway engineer and commissioner for Adams County, Wisconsin, has resigned, effective immediately.

ABEL WOLMAN has resumed his duties as chief of the Bureau of Sanitary Engineering of the Maryland State Department of Health after two months' leave of absence. During this period Mr. Wolman gave a course of lectures on sanitary engineering at Harvard University, but returned to Baltimore each week to lecture at the Johns Hopkins School of Hygiene and Public Health.

W. J. HOWLAND, civil engineer of Andes, N. Y., has been appointed county superintendent of highways of Delaware County, New York.

Obituary

LINCOLN O. KENNEDY, who since 1919 has been county engineer of Walla Walla County, Washington, died Nov. 28 of apoplexy on the way from his office to his home in the city of Walla Walla. Previous to becoming county engineer Mr. Kennedy had been engaged in construction work in the vicinity and before that had been an engineer with the Oregon-Washington R.R. & Navigation Co. and the Northern Pacific R.R.

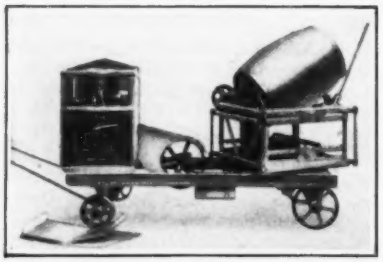
From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

British Road Show Exhibits New Equipment

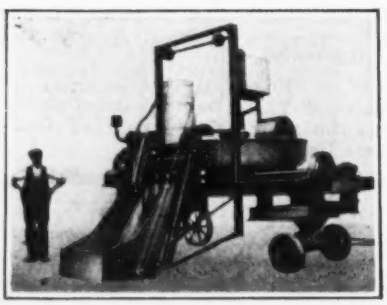
Tendency in Equipment Design Is Toward Lighter and More Portable Units

ENGLAND held its first "Road Show" since 1923 during the week of Nov. 19-26. It was officially known as the Public Works, Road and Transport Exhibition. The exhibition was reviewed in the Nov. 20 issue of *Engineering*, the English publication, and the part of this review that treats of the trend and emphasis in equipment design is set down here. The illustrations are not necessarily exemplary of prevailing types of mixers, but are outstanding in their differences from our drum-type mixers. These latter were also in evidence at the exhibition of both English and American manufacture.



BARREL-TYPE MIXING DRUM MIXER

"Compared with the 1923 show," says the account, "the exhibit did not indicate much change in individual categories of the plants concerned. The trend was then and continues toward lighter and more portable material preparing units, a larger use of materials of the asphalt or bitumen type which call for lighter, and for some selections, even a more or less specialized form of consolidating and finishing plant. Despite this trend toward lighter units, steam looks like holding sway over the combustion type for the heavier units, but the internal combustion type has the field to itself in what concerns the most interesting developments referred to. There probably has been no greater development than that which concerns concrete mixers. From being almost solely associated until a few years ago with dock making and other big works involving deep excavation and filling in, there has been developed a large demand for, and use of, portable concrete mixers, and more recently concrete spreaders, which have shortened the time, if not in all cases curtailing the cost, of up-to-date road making."



CONCRETE MIXER FOR SEMI-DRY MIX

The pan contains blades for turning over the semi-dry mixture and the roller, seen projecting over the top of the pan, is used to press the mixture.

It will be interesting to note whether tendencies parallel to these are in evidence at our Good Roads Show in Chicago, Jan. 11-15.

Manufacturers' Catalogs Must Be Understandable and Exact

The preparation of catalogs by American manufacturers and dealers for the use of foreign buyers is a matter of much importance and one that should be studied from every angle, says an editorial in *Commerce Reports*, the weekly survey of foreign trade published by the Bureau of Foreign and Domestic Commerce.

From certain comments made in foreign technical journals, it is apparent that in some quarters, at least, the American catalogs leave something to be desired. "If the subject matter of a catalog is not at once clear to the foreign buyer, the mistake is much more serious than in the case of a catalog used in the United States since the foreign buyer cannot afford the time to write to the manufacturer for an explanation of any confusing detail. A well arranged and easily comprehensible catalog in English is better than a poorly translated compilation in a foreign tongue, though in general it is highly desirable to address a prospective purchaser in his native tongue." It is especially important that any translation should be made by some one familiar with the current idioms of the foreign country.

The editorial goes on to say that a catalog, to be of greatest value, should be kept up to date. "It has been suggested that this may be accomplished by forwarding circulars from time to time of the same size and type as the pages of the catalog. In this way it is possible for a foreign buyer, upon receiving a circular which supplements some part of the catalog, to insert it immediately in its proper place. As a matter of fact, it might be advisable in many instances for the American manufacturer to have his printed matter standardized in the respects indicated, so that all advertising material could be conveniently filed with the catalog. The greatest care should be taken in compiling and publishing the catalogs so that the foreign buyer who receives them will place them carefully in his files instead of disregarding or discarding them."

Not only are these suggestions important to manufacturers engaged in foreign trade, but may well be considered in their literal significance by all manufacturers. Standardization of trade catalogs as to size and in many instances more care and system in compiling their contents will save manufacturers large sums of money, which at the present time are going into the waste basket.

Lengthening the Life of Link Chains

The following pertinent information on efficient operating methods designed to lengthen the life of link chains is found in the *Excavating Engineer*, published by the Bucyrus Co., Milwaukee: "A severe and unavoidable wear on the outside of hoisting chain links occurs when the second wrap starts on the drum. The links climb, and when slipping down to a firm bearing position, cause a tearing action, which, especially in the absence of proper lubrication, will wear the chain rapidly. This cannot be avoided, but the life of the chain can be more than doubled by turning the chain end for end and upside down; in fact, any way that will keep changing the position of the link on the drum.

"Another method suggested to us is to attach to a new chain a piece of old chain long enough to make about one and one-half wraps. Later, when the new chain shows sufficient wear, remove this extra piece and attach the hoisting chain directly to the drum. Suppose this short extra piece is applied when a new chain is put on. When the chain shows enough wear, turn it upside down, then end for end, and later upside down. Next the short piece may be removed and the whole procedure repeated—eight changes."

Business Notes

AMERICAN CREOSOTING CO., Louisville, Ky., announces the appointment of E. C. Chacey as sales representative in charge of their sales office in New York City.

MUNDY SALES CORP., 30 Church St., New York, N. Y., U. S. distributors for the J. S. Mundy Hoisting Engine Co., has open some exclusive sales territory. Charles H. Foster, secretary, would like to hear from equipment distributors who may be interested in this hoist account.

ROY A. YINGLING, field engineer, the Kentucky Rock Asphalt Co., Inc., Kyrock, Ky., has resigned to take effect Jan. 1. He will become associated with the Perfect Classifier Co., manufac-

turer of sand and gravel washing equipment, with headquarters at Nashville, Tenn.

C. E. PHILLIPS has been appointed representative in charge of the Wilkes-Barre office of the Allis-Chalmers Manufacturing Co., Milwaukee. Mr. Phillips, who was formerly connected with the Philadelphia office of the company, succeeds Guy V. Woody.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., is opening a branch sales office at Houston, Tex., in charge of R. I. Moore, who was previously located in their Dallas office. The Houston office will be operated as a branch of the Dallas district, of which E. W. Burbank is district manager.

PITTSBURGH-DES MOINES STEEL CO. announces the closing of its Richmond, Va., office and the opening of an office in Atlanta, Ga. The new office will be in charge of Charles R. Ford, and will serve the States of North Carolina, South Carolina, Tennessee, Georgia, Alabama and Florida.

Equipment and Materials

Machine Adaptable for Snow Loading and Other Bucket Elevating Work

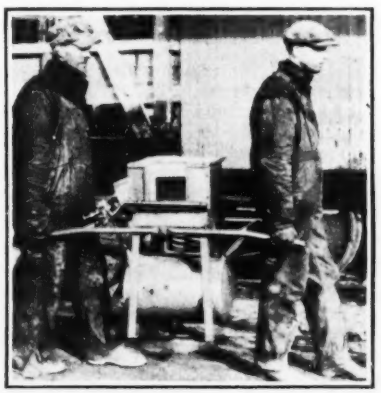
A new piece of equipment manufactured by the N. P. Nelson Iron Works, Passaic, N. J., may be employed for clearing streets and roads of snow and ice during the winter and as a bucket elevator for loading sand, gravel and cinders during the rest of the year. For the latter type of work, the bucket elevator is installed on the chassis of the machine shown in the illustration.

The snow loader as illustrated is mounted on a standard Fordson tractor using special wheels with staggered cleats, so as to provide sure and easy movement over snow and ice covered streets. The spiral feeder at the back end of the machine digs the snow and ice to a width of 7 ft. and delivers it to the center of the elevator, within easy reach of steel plate scrapers attached to an endless chain. These scrapers push the snow and ice before them into a steel trough to the top of the elevator which discharges into a swivel chute. This chute is pivoted and permits both straight and side loading of trucks. The clearance under it is 10 ft.

The operator stands on the side platform and moves the machine backwards just as fast as the snow and ice are handled by the outfit. Besides the operator, one laborer with a long rod controls the swivel spout so that the trucks are loaded evenly, thus doing away with trimmers on the truck. The tractor is equipped with a quick starting device and a flexible grader attached to the feeder, allowing the machine to clean up very close on rough streets. In fresh snow, it is claimed the loader handles from 6 to 9 cu.yd. per minute.

All Rivets in New Oil Forge May Be Seen by Operator

The new oil-burning rivet forge manufactured by the Johnston Mfg. Co., Minneapolis, Minn., features a very low front wall which permits the operator to look directly down into the forge and see every rivet that is being heated. This design also places the rivet within easy reach of the tongs. The convenience of the operator is also facilitated by venting a large portion



of the gases through an opening at the rear of the chamber. The gases coming out of the charging opening are held back by an air curtain. This curtain has large holes that are not subject to clogging, but nevertheless are claimed to use a very small amount of compressed air.

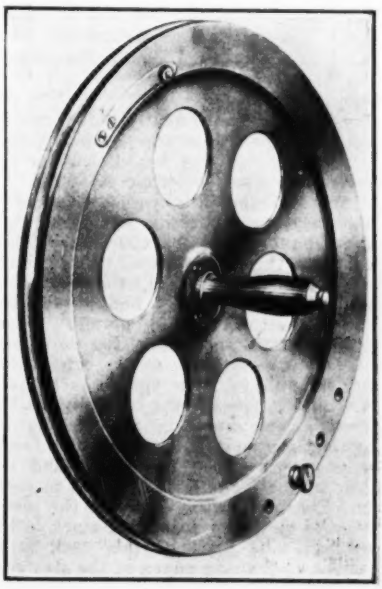
As shown in the illustration, the attached handles permit the equipment to be carried well above the ground so that it passes over material without interference. A vacuum type oil burner is used which has no choke or restriction in the oil feed line. The oil supply to this burner is regulated indirectly by an air valve which it is claimed cannot clog or vary. The burner has only two working parts. These are the two needle point air valves, one of which regulates the compressed air and the other regulates the oil feed indirectly. It is claimed that the operation of the burner is not affected by the wear of the parts. The burner is designed so that the oil feed automatically increases and decreases with the air pressure and a proper and uniform flame is maintained regardless of large variations of pressure in the air lines. As a result of the uniform oil feed and double atomization obtained in this burner, it is claimed that it requires less than half as much compressed air for its operation as other styles of burners which regulate the oil by means of valves.

Nickel-Steel Tapes for Use in Accurate Surveys

Through their U. S. agents, the R. Y. Ferner Co., Investment Building, Washington, D. C., the Société Genevoise d'Instruments de Physique, Geneva, Switzerland, is putting on the market a line of accurately graduated invar tapes and an aluminum reel adapted for them. The blank tape, as well as the invar wires for this use in precision base measurements, have been supplied by the Société Genevoise for a number of years. It now announces that on account of the increase in demand, it has installed a bench for the precise graduation of these tapes.

Invar, the alloy or nickel and steel having about 36 per cent of the former, has a coefficient of expansion at room temperatures of about $\frac{1}{2}$ to $\frac{1}{5}$ that of steel, and for this reason is specially suitable for working standards of length, since the necessity for a precise determination of the temperature of such a standard is largely eliminated. It is also said that the material is highly resistant to corrosion and will take a polish adapted to the fine rulings necessary in accurate standards.

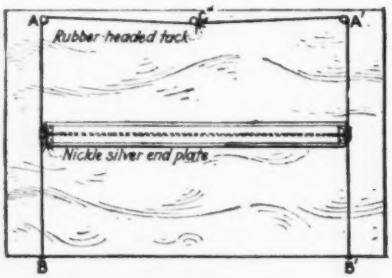
Since these tapes are generally used for measuring a base of considerable length, or on traverse work involving repeated stepping off of the tape length, and because of the more expensive graduation of the tapes, it is not usual to have many intermediate graduations, employing, rather, the common steel tape for measurement of the last small fraction of a tape length in a base. The 100-ft. tapes, for example, have graduations at only each 10-ft. point or in some cases only at each 25- or 50-ft. point. They are made standard at 20 deg. C., the 100-ft. tapes being graduated under a horizontal tension of 20 lb. when supported throughout their entire length.



The use of invar tapes has been subject to two difficulties. The first of these is a tendency of the metal to change its length with time, most of this change occurring in the first year after it is made and a large part of it the first month. The company claims to have eliminated this difficulty by means of an artificial aging process to which the tape is subjected before being graduated. The second difficulty lies in the fact that the metal does not have the temper of steel and must, therefore, be handled with more care than steel tape to prevent kinks occurring in the ribbon with consequent change in length. To prevent any permanent set in the tape it must be wound, when reeled, on a circle at least 16 in. in diameter. To facilitate the easy and safe handling of the tape an aluminum reel has been provided. The tape when wound on the reel is securely fastened at its outer end by a pin which is inserted in the holes through the outer rim, and in a loop at the end of the tape.

Parallel Straightedge Rapidly Secured to Drawing Board

The new straightedge for drawing parallel lines designed by A. P. Jacobs and now being marketed by Keuffel & Esser Co., New York City, has several distinct advantages, among which are the fact that it may be secured to any drawing board longer than the straightedge, that it may be quickly transferred from one drawing board to another, that it does not project beyond the ends of the drawing board and thus cannot be accidentally struck by any one passing the board, and finally that it can be set up to operate on any particular part of a large drawing board, leaving the remainder clear for other work.

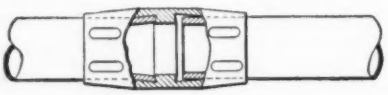


The instrument is rapidly secured to the drawing board by means of four special tacks and one thumbtack. Except for these five tacks, the straightedge is self-contained, the necessary pulleys being entirely housed between the nickel silver end plates. These plates above and below the cord preclude any possibility of the cord jumping the pulleys. The special tacks have a shoulder beneath the head so that the small cables cannot be fastened tightly against the board. This shoulder forms a groove between the board and the head of the tacks for the cables to move in. The tack in the center of the board may be moved to adjust for slack in the cables. The head of this tack is of rubber so that the edges of the straightedge cannot be damaged. The cables are made of 16 copper strands. The cable passes from B across the straightedge to A'; through C and A, and then back across straightedge to B'. It passes from one end of the straightedge to the other through a conduit formed within the blade.

The body of the straightedge is formed of bakelite, while both edges are lined with transparent xylonite, properly beveled. This instrument is available in lengths of 42, 60, and 72 in.

Connecting Sleeve on Pipe Piling Is Self-Locking

Several advantages are claimed for the new sleeve that has been designed by the Pierce Foundation Corporation, New York City, for joining the contiguous lengths of the hollow steel cylinders used in its foundation system. This system consists of the installation of hollow steel cylinders varying from



10 to 18 in. in diameter and from ⅛ to ½ in. in thickness. The cylinders are driven in sections of 20 to 22 ft. in length to solid rock, cleaned out by compressed air and filled with concrete.

The old type of sleeve was an inside connection and the projection in the pipe is claimed to have hindered the cleaning. Also it is said that often the driving of the second section slipped past the sleeve, causing telescoping and thus making the joint the weakest part of the pile. The new type of sleeve, as shown in the illustration, is placed upon the outside of the steel cylinder thus giving a full size column of concrete throughout the length of the pile, and a watertight joint. This new type of sleeve is claimed to eliminate any possibility of the telescoping of the adjacent section. The self-locking feature of the splice is claimed to result from a slight expansion of the ends of the pipe when driven firmly into the sleeve. This expansion, as may be seen in the illustration, is made possible by sloping the internal double-face seat of the sleeve slightly outward. It is claimed that the joints will support 3 tons with no deflection when used as a beam between supports on 20-ft. centers.

Concrete Road Forms Contain New Improvements

A strong and rigid steel road form has been perfected by the Dravo Equipment Co., Pittsburgh, Pa., in which several new features are incorporated. The stake pocket has been designed to receive a square stake so as to secure a maximum area of contact between the stake and the wedge, and consequently maximum supporting strength. Sturdiness is obtained by building the pocket with a secure footing on the base of the rail instead of riveting it to the web. The pocket is shielded in such a way that grout cannot lodge in it. The wedge is driven into place after the stake is set, thus forcing and holding the rail-form to line and grade.

The connecting joint is of the male and female type and a steel wedge is added as a further precaution for securing exact alignment. A rail can be

taken out of a string of forms at any place along the line without disturbing adjacent members due to the fact that the joint is broken by a transverse movement and not a vertical or longitudinal shift of the rails. Each rail end serves as a support for the next rail to be set, and thus automatically transfers the grade and eliminates the necessity for a grade check on both ends of each rail. The angle-cut of the rail ends is a type of construction that is claimed to prevent the wheels of a finishing machine from dropping into a joint, which is one of the many causes of transverse waves in finished pavement. The details of this joint are shown in the accompanying illustration.

Publications from the Construction Industry

Water Softening — NATIONAL LIME ASSOCIATION, Washington, D. C., has just issued a bulletin of 48 pp. giving a treatment of the subject of water softening for municipalities, railroads, raw water ice plants, and industrial concerns in as nearly as possible non-technical language. There are four main chapters in this new publication, each relating to a particular phase of water softening or treatment. These chapters have been prepared by authorities and carry a valuable message. They are as follows: Advantages of the Use of Lime in Water Treatment; Cost of Impurities in Locomotive Water Supply and Value of Water Treatment; Raw Water Ice; and Some Variants from Accepted Formulæ in Water Flows.

History — BRIDGEPORT BRASS CO., Bridgeport, Conn., in commemoration of its 60th anniversary, is distributing in pamphlet form an account of the company from its beginning in 1865 up to the present day. In addition to giving the history and development of the Bridgeport Brass Co., the booklet gives a short history of brass manufacturing progress.

Drainage Gates—CALIFORNIA CORRUGATED CULVERT CO., Los Angeles, has issued a small booklet on the important uses of its automatic drainage gates. Eight different uses for these gates are described and illustrated..

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

1925 Breaks All Construction Records—New Year Will Probably Run a Close Second Barring Further Tightening of Money Rates or Drop in Bond Issues

The greatest building year in history is drawing to a close without evidence of a let-up in the boom. According to *Engineering News-Record* the trend since the beginning of 1924 has been so definitely upward as to indicate that the country has accepted a new standard in building construction. Million-dollar projects are no longer particularly noteworthy.

The 270,000 individual buildings in the 1925 program total $5,610,000,000. Of these, 231,000 are residential, worth $3,042,000,000.

The boom is confined to buildings. Engineering construction (other than buildings) is going forward at much the same rate as during the year 1924.

Total construction for the entire country for the year 1925 will approximate $7,490,000,000, breaking all records in the annals of the construction industry. Of this total, $1,880,000,000 represents construction other than buildings and half of this amount, large engineering construction projects, including roads.

Taking a minimum of $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial and other buildings, the following tabulation shows the estimated total for the country during 1924 and 1925.

ESTIMATED VALUE OF CONTRACTS LET IN THE U. S.

	Buildings		Other	
	Commercial	Industrial	Construction	Total
1925				
New England	$143,908,000	$27,633,000	$27,509,000	$199,050,000
Middle Atlantic	563,984,000	50,015,000	284,584,000	898,583,000
Southern	82,199,000	26,226,000	137,000,000	245,425,000
Middle West	237,104,000	51,464,000	174,428,000	462,996,000
West of Mississippi	168,390,000	43,539,000	200,113,000	412,042,000
Far West	142,292,000	25,143,000	119,416,000	286,851,000
	$1,337,877,000	$224,020,000	$943,050,000	$2,504,947,000
1924				
New England	$95,846,000	$25,794,000	$29,916,000	$151,556,000
Middle Atlantic	339,291,000	54,469,000	207,392,000	601,152,000
Southern	52,555,000	19,355,000	136,162,000	208,072,000
Middle West	211,666,000	56,324,000	163,049,000	431,039,000
West of Mississippi	120,835,000	22,976,000	196,811,000	340,622,000
Far West	115,237,000	26,051,000	125,381,000	266,669,000
	$935,430,000	$204,969,000	$858,711,000	$1,999,110,000

Study of the various factors that determine new construction indicates another big year ahead. Buildings contemplated already amount to $5,500,000,000. Another billion and a half in contracts may be expected for construction other than buildings. Thus, 1926 has all the promise of a $7,000,000,000 year.

Engineering News-Record's calculation of total construction in the United States, 1920 to 1925, is as follows:

1920	$3,621,000,000
1921	3,560,000,000
1922	4,927,000,000
1923	5,483,000,000
1924	6,012,000,000
1925	7,490,000,000

Construction conditions look particularly favorable in the South, where 10 per cent of the big work of the country is done. Improvement is also looked for in the vast region between the Mississippi and the Mountain states.

There are three possible deterrents to be watched: (1) tightening in the money rate; (2) decline in volume of bond sales for public work; (3) smaller volume of contemplated engineering construction (not buildings) than a year ago.

Steady Gain in Steel Demand Since September 1, 1925

Steel buying, so far as rise and fall in demand is concerned, showed very much the same characteristics this year as it did throughout 1924. Volume of sales, however, was consistently heavier, month for month, during 1925.

Both years showed a gain in February demand. After that came the steady downward trend to the usual period of mid-summer dullness. Last year there was improvement in demand during August; this year the pick-up occurred in September. Judging from orders on books of the U. S. Steel Corporation, October gained 10 per cent over September of this year, while November sales increased over 11 per cent, compared with the month preceding.

December, 1925 will probably show a gain in demand of about 19 per cent over November, if the present trend is followed. Steel rail buying, particularly, may help to swell the tonnage for the current month.

The following tabulation shows unfilled orders on books of the U. S. Steel Corp., on the last day of each month:

	Tons	
	1925	1924
Jan. 31	5,037,323	4,798,429
Feb. 28	5,284,771	*4,912,901
Mar. 31	4,863,564	4,782,807
Apr. 30	4,446,568	4,208,447
May 31	4,049,800	3,628,089
June 30	3,710,468	3,262,505
July 31	3,539,467	3,187,072
Aug. 31	3,512,803	3,289,577
Sept. 30	3,717,297	3,473,780
Oct. 31	4,109,183	3,525,270
Nov. 30	4,581,780	4,031,969
Dec. 31	.....	4,816,676

*Feb. 29

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial buildings.

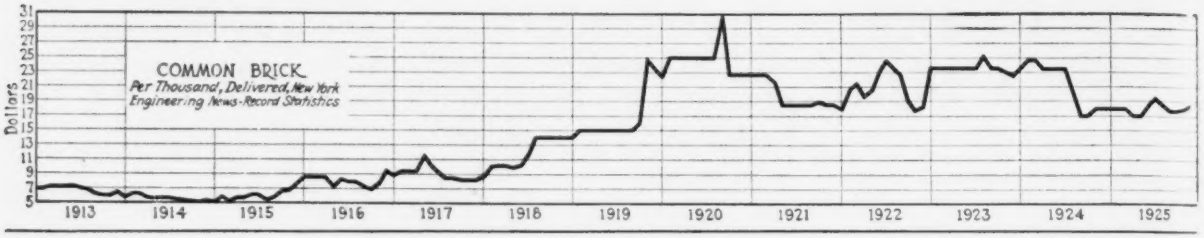
Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
December 17, 1925	$17,142,000	$35,444,000	$52,586,000
December 10, 1925	12,554,000	31,584,000	44,138,000
December 18, 1924	11,664,000	30,537,000	42,201,000
Heaviest Week			
1925, Sept. 3	16,215,000	69,424,000	85,639,000
1924, May 8	26,370,000	38,829,000	65,199,000
January 1 to Date			
1925	1,011,128,000	1,459,860,000	2,470,988,000
1924	939,799,000	1,012,565,000	1,952,364,000

Weekly Construction Market

FIRMNESS prevails in the current market for basic building materials. Brisk demand with upward tendency in price, affect such items as brick, lath, hardwood and yellow pine flooring, pine timbers, common boards, dimension lumber, special cutting, and finish.

The pig-iron market is firm, with foundry coke up $1 per ton at Connellsville, compared with a week ago. Iron and steel scrap is moving slowly at present. Orders on books of the U. S. Steel Corporation, Nov. 30, were heavier than for the corresponding date in any year since 1922. Plates are particularly firm just now, with quotations ranging from $1.70 to $2 per 100 lb., Pittsburgh. Reinforcing bars are $2 to $2.10, with slightly less demand than a week ago. Structural shapes have hovered at $1.90 to $2 per 100 lb., Pittsburgh, since May, 1925; less than carload lots at $2.10



	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.90	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	$3.75
Structural rivets, 100 lb.	4.50	4.45	4.75	3.50	3.75	4.65	5.00	3.75	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.40	3.38	3.00	3.25	3.77½	3.35	3.25	2.30
Steel pipe, black, 2½ to 6 in. lap, discount	48%	55%	53.6%	51%	54.25%	36%	39.2@51%	45%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@52.60	+48.00	54.00	50.20@51.20	53.00	64.00	53.00	55.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.70	2.25	2.05	2.10	2.32	2.84	2.31	2.65	1.80
Gravel, ¾ in., cu.yd.	1.75	2.20	2.38	2.00@2.20	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd.	1.00	1.65	2.00	2.25	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.20	2.83	2.00@2.20	1.75	2.50	2.15	3.00	1.50
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	+62.00	34.00	+60.00	57.00	36.75	32.75	27.00	25.00	60.00
Lime, finishing, hydrated, ton.	18.20	22.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl.	2.25@2.75	1.30	1.85	1.30	1.35	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000.	17.50@19.50	10.50	11.10	12.00	13.50	12.00	15.50	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0893	.10	.075	.....	.075	.....	.10	.12
Hollow partition tile 4x12x12, per block	.1112	0893	.10	.075	.07	075	.108	.10	10
Linseed oil, raw, 5 bbl. lots, gal.	.99	—1.07	1.13	+1.02	1.11	—1.23	—1.10	1.12	1.14
Common Labor									
Common labor, union, hour.	.62½@.75	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour.	.....	.25	.30@.50	.82½	.45@.55	.35@.50	.50	.50	.20@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 62½c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job; pine is 4-in. instead of 3-in.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of December 3, the next on January 7.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.93). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Business Briefs

Call money ranged from 5 to 5½ per cent, Dec. 14; year ago, 3 per cent.

Time loans: sixty-ninety days, 4¾@5 per cent; four-six months, 5 per cent.

Commercial paper: best names, 4½ per cent; others names, 4¾ per cent.

On December 1, 1925

E. N.-R. Construction Cost Index Number 205.95

E. N.-R. Construction Volume Index Number 194

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month

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